PETROLEUM REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

September, 1945
Volume 24, No. 9

A Gulf Publishing Company Publication
EDITED MONTHLY AT HOUSTON, TEXAS

GRADY TRIPLETT
Editor

Copyright, 1945

CONTENTS

Chemical Composition and Road Antiknock Performance of Possible Postwar Motor Fuels 97
Jane F. Jordan

Functions and Fundamentals of Temperature in Refinery Process Control 104
David M. Boyd, Jr.

Measurement of Solids in TCC Process 108
A. E. Kelley

Manufacture of Lubricating Oils 112
V. A. Kalichevsky

Water Treatment an Important Feature in High-Octane Processing 117
M. P. Robinson

Commercial Production of Pure Hydrogen from Hydrocarbons and Steam 119
R. M. Reed

Design of the Goleta Dehydration Plant 123
Richard H. Hull

Calculation of Plate Columns for Binary Distillation by the Ponchon Method 127
Robert R. White

Measurement of Flow of Fluids Through Orifice Meters, With Particular Reference to the Measurement of Liquids and Steam 133
Wm. L. Cowan

Shell Researchers Report Progress With Jet Plane Turbine Fuel and Lubrication 144

Care and Servicing of Fire Extinguishers 152

War's End Releases Pent-Up Plant Building Program 154

Departments

Look Box 93

How to Do It 146

The Month in the Industry 161

Abstracts of Papers Presented by Division of Petroleum Chemistry of the American Chemical Society 196

Science and Technology Abstracts 212

About Equipment-Service Suppliers 258

New Equipment, Manufacturers' Literature 273

Index to Advertisers 286

Petroleum Refiner is indexed by Industrial Arts Index.

SPECIALIZED OIL JOURNALS

Published by

THE GULF PUBLISHING COMPANY

OFFICE OF PUBLICATION

3301 Buffalo Drive, Houston, Texas

R. L. DUDLEY, *President*

A. L. BURNS, *General Manager*

J. KENT RIDLEY, *Managing Editor*

TOM W. NELSON, *Advertising Manager*

NEW YORK: Room 523, 250 Park Avenue, Dick Swinsky, Manager.

CLEVELAND: 1010 Euclid Avenue, C. L. Haskins, Manager.

CHICAGO: 332 S. Michigan Avenue, H. G. Fitzpatrick, Manager.

LOS ANGELES: 426 W. W. Wilson Building, Huntington Park, California, J. W. Curts, Manager.

TULSA: 1304 Hunt Building, J. F. Carter, Jr., Manager.

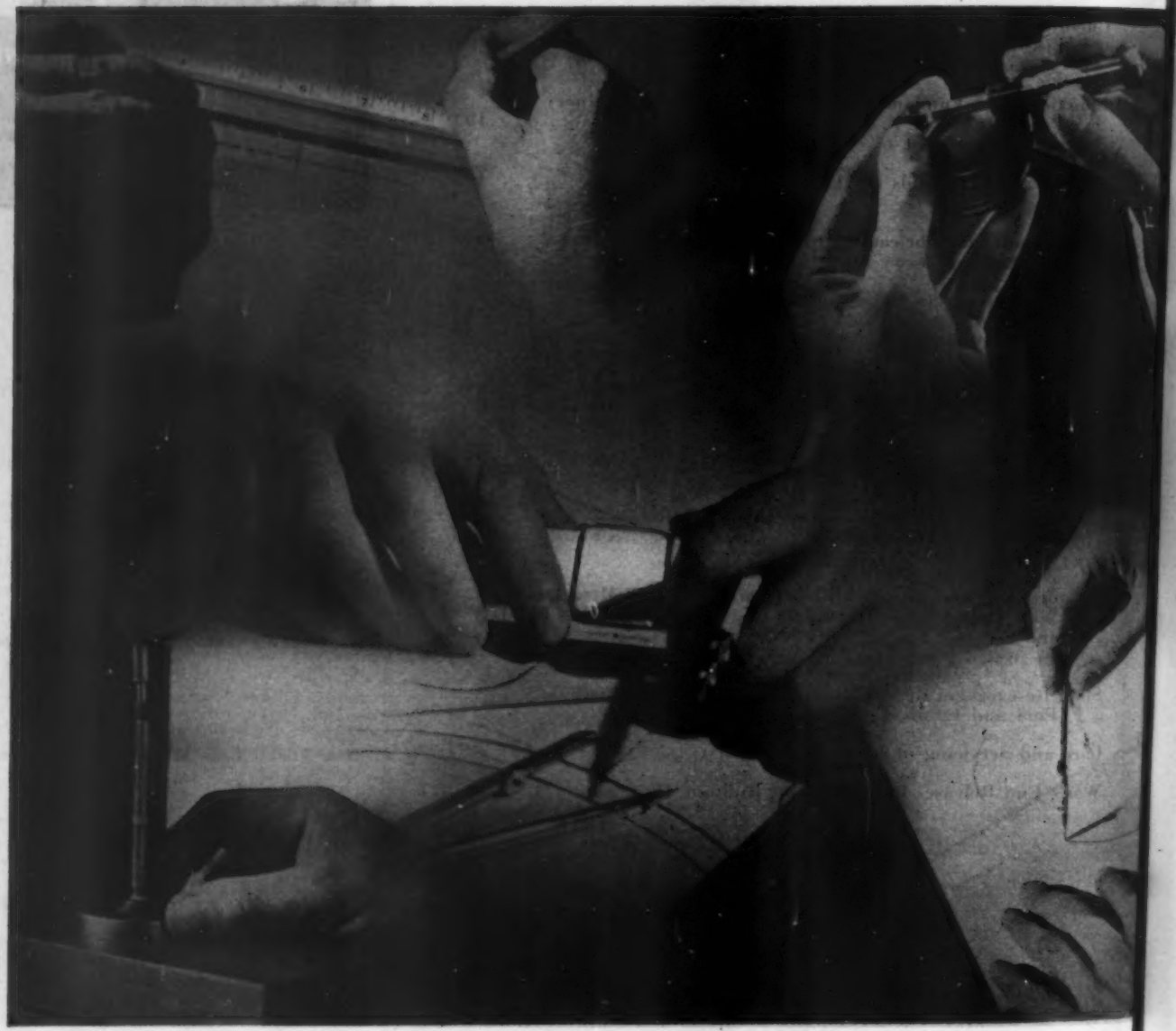
FT. WORTH: 203 W. T. Waggoner Building, H. H. King, Manager.

Single copies 35 cents (except special issues). Subscription price, domestic and foreign, $2.00 a year; 2 years $3.00; 3 years $4.00. Entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act of March 3, 1879. Advertising rates on application.

Copyright 1945 by The Gulf Publishing Company.

MASONEILAN PRESSURE REGULATORS ★ AUTOMATIC CONTROLS ★ RECORDERS ★ INDICAT

HELPING HANDS



Masoneilan equipment—Built-up to the job, not down to a pric

VOLUME 24, NO. 9 SEPTEMBER, 1945

PETROLEUM
REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

A GULF PUBLISHING COMPANY PUBLICATION

THE LOOK BOX

IT WAS a tired but confident refining industry which heard the Japanese admit defeat. Over a period the plants of the United States had processed close to 5,000,000 barrels of crude oil each day.

Pause Before Another Start

Daily output of 100-octane aviation gasoline reached 530,000 barrels and another 75,000 barrels was coming out of foreign plants. Production of the super aviation fuel, whose specifications had not been made public, had started.

It was an industry ready to forge ahead, still it welcomed the opportunity of pausing to check its equipment. Many of its newer units were processing far in excess of design ratings. Many old plants had been put back on stream. The equipment needed the attention of inspectors, then required maintenance.

Meanwhile sufficient capacity was kept operating to provide limited military requirements and to restore qualities to civilian products. Within a week motor fuels of the 74-75 octane rating for regular gasoline and 79-80 for premium grades were ready for shipment.

Government-owned plants for making 100-octane motor fuel came into a 30-day period prior to the end of buying contracts. Meanwhile negotiations for the lease or purchase of the plants got under way. Although deals have not been completed, the location of plants leaves no doubt that present operators are in favored positions for ownership.

What it all amounts to is that the industry, after shifting easily into civilian requirements, is making ready to match its motor fuel to the new automobiles whose specifications doubtless will include slightly higher compression ratios.

AS THE petroleum industry turns its attention to peacetime pursuits it is fitting to take credit for its wartime accomplishment. The fuel, the lubricants, a part of the explosives and a part of the rubber came out of the research and manufacturing accomplishments of petroleum refining. None of this is more than the industry should have done.

Glance Backward

Contributions to other phases of the war effort were so numerous that listing them is impractical.

Most of what the industry learned and accomplished in war has application to a world at peace. It is encouraging to see the industry turn quickly to its peacetime obligations.

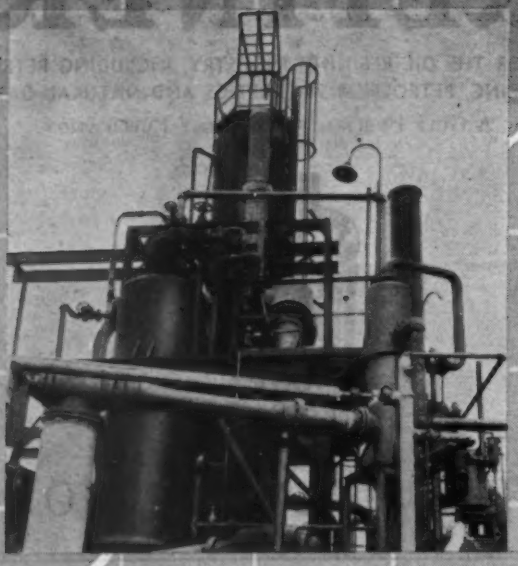
UNTIL the energy inherent in the atom can be controlled it will remain a destructive force only. While it is reasonable to expect this control, it is rash to expect it so soon that other energy sources, oil included, are of this day obsolete. That man has come within reach of an unlimited source of power is accepted; that it will require time for learning how to control it is within reason.

Not Yet Obsolete

Meanwhile the refining of oil holds sufficient promise that it is in order to note the enlarging of research programs and the plans for bringing plants up to modern standards. In time science doubtless will learn to control the energy of the atom just as it learned how to release it in a bomb. Meanwhile there is need for the commonplace source of energy, oil included.

Scientists have recognized the power inherent in

Dowtherm on the job!



It Took Dowtherm's Harnessed Heat to Lick These Losses

Controlling the heat needed for distilling fatty acids . . . a difficult problem! It wasn't solved till the Dowtherm vapor method *harnessed* that heat and brought high-temperature losses to a minimum.

The technical director of a big food-packing house recalls how fatty acids broke down under excessively high temperatures in direct-fired cast iron pot stills. Changing to direct-fired pipe still heaters didn't stop the decomposition. Moreover, the tubes quickly choked up with coke . . . shutdowns were frequent.

The final answer? A Dowtherm vapor heating system. Large Dowtherm units have now been giving dependable service for years. Temperatures can be closely controlled . . . held constant at exactly the right level for safe fatty acid distillation.

That's the story behind just one Dowtherm installation in one industry. It could be matched by hundreds of satisfied Dowtherm users in other fields. If you have a process that requires smooth, precise temperature control up to 725° F. . . . if you're working toward higher product uniformity, reduced maintenance, speedier production . . . you'll want to investigate Dowtherm. A line to Dow will bring you the information.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit
Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

Dowtherm

The high-temperature low-pressure heat transfer medium

DOW

CHEMICALS INDISPENSABLE TO INDUSTRY AND VICTORY

the atom. Finally under the urge of war, the marshalling of men and the expenditure of $2,000,000,000 release of this energy was accomplished. The lag between assurance of the energy and means of its release was such that science can be pardoned if even a longer period is required for control of this energy.

The magnitude of atomic energy is staggering. The first bomb was credited with explosive force equal to 20,000 tons of TNT. One pound has been calculated to hold heat energy equal to 6,000 barrels of fuel oil (and the pound will cost six times as much as its fuel oil equivalent). The fuel oil comparison permits an estimate of the problem of control. The oil can be put in tanks and through valves, piping and pumps, and can be used when and where needed.

It will require much more than tanks, pumps, piping and valves to permit unhampered use of atomic energy. That mankind has come into possession of a source of unlimited energy is accepted. How and when he may use it defy prediction.

New Fuel At Hand

WHEN the war ended the industry was into production on its super aviation fuel, whose specifications have not been made public. Even the plants that had been designated to make it were not announced. A news release from the Petroleum Administration for War credited the fuel with qualities to "provide an increase in engine performance which can be translated into greater speed, longer range or higher load factor."

Its adaptation to existing motors could be accomplished by changes in carburization and through supercharging.

Time for Choosing

WITH natural rubber in prospect the time for choosing between it and the chemical product comes up for decision. This decision has its political as well as its economic angles. Domestically there is the conflict between oil and alcohol as the source of butadiene.

All indications point to a victory for one chemical rubber, Butyl, which will be used for inner tubes. It holds better than natural rubber and has superior oxidation qualities.

The whole rubber problem can be appreciated by realizing that world capacity, with the plantations restored and chemical rubber plants operating, would be around 3,000,000 tons per year. The demand is half that. There must be adjustments. An estimate of what is in prospect has been put down by John L. Collyer, president of The B. F. Goodrich Company, part of which is quoted:

"Synthetic rubber can make a major contribution in limiting the extent to which prices for natural rubber increases. Today, however, synthetic-rubber costs and prices are complicated by a problem of base-material costs. Approximately half our present total synthetic rubber capacity is based on alcohol butadiene and the balance on petroleum butadiene . . . The cost of synthetic rubber from grain alcohol is above 40 cents a pound, while that produced from petroleum is about 14 cents a pound, exclusive of amortization and depreciation costs.

"As long as our total needs for synthetic rubber are substantially above 500,000 tons annually continued use of grain alcohol may keep the average cost of synthetic rubber as high as 30 cents a pound compared with a prewar condition in which natural rubber could be laid down in New York and sold at a fair profit at 12 cents a pound.

"When this need falls below 500,000 tons a year our total synthetic requirements can be based on petroleum butadiene and synthetic rubber can then exercise its influence on natural rubber prices."

What is more encouraging is the prospect of producing GR-S rubber at less than the 14 cents per pound average price by taking advantage of the most efficient of the peroleum butadiene plants. These units are all owned by the government, hence cost data has not been made public. It is known, however, that several have far exceeded design throughout and that costs are substantially lower than average figures.

No Shortage Of Ingenuity

THIS part of a letter recently received from Emeric Kroch, Brussels, Belgium, brings the encouragement that frequently comes out of adversity. Those who fear the day a shortage of oil can take heart in what has been done in occupied Europe. Kroch wrote concerning re-entry of his subscription to PETROLEUM REFINER, which he would like to have back-dated to 1940:

"My principal business being refinery engineering and liquefied petroleum industry, my activities have been very much curtailed during the German occupation. However, I kept myself and my organization busy with alternate motor fuel developments, especially compressed gas and ammonia.

"We have made considerable progress along these lines as in Belgium the liquid fuel supply has been cut to about 2 percent of the prewar figure, while the number of commercial trucks authorized to circulate stood at about 25 percent. More than 90 percent of trucks have been operated on alternate fuels."

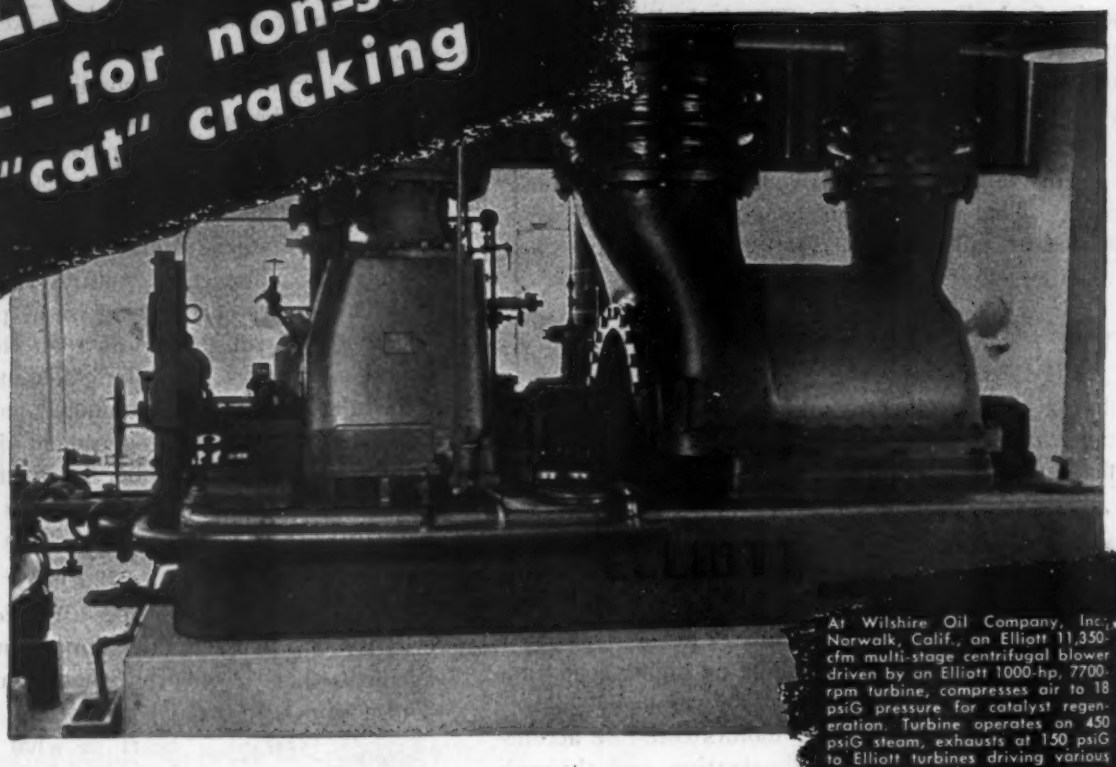
It is likely that these substitute fuels are not as satisfactory as gasoline, perhaps not as cheap. The item for memory is that when gasoline was denied, men found other fuels.

"That which is really good for the American people is good for business."

J. HOWARD PEW, *President Sun Oil Company*

NON-STOP ELLIOTT BLOWERS

---for non-stop "cat" cracking



At Wilshire Oil Company, Inc., Norwalk, Calif., an Elliott 11,350-cfm multi-stage centrifugal blower driven by an Elliott 1000-hp, 7700-rpm turbine, compresses air to 18 psiG pressure for catalyst regeneration. Turbine operates on 450 psiG steam, exhausts at 150 psiG to Elliott turbines driving various pumps.

The success of the fluid "cat" cracking process is contingent upon continuous operation. Thus, the blower which furnishes the air for circulating and regenerating the catalyst has often been called the "heart" of the plant. Elliott centrifugal blowers are measuring up to the demand for smooth, non-stop performance in many of the catalytic cracking plants supplying our wartime requirements for high octane gasoline.

The turbine or motor is linked with the blower in a complete Elliott-built unit, with the advantage of placing performance responsibility on a single manufacturer.

Full details on these units upon request. Consult our nearest district office.

P-1071

ELLIOTT COMPANY

Centrifugal Blower Dept., JEANNETTE, PA.

Plants at: JEANNETTE, PA. • RIDGWAY, PA. • SPRINGFIELD, O. • NEWARK, N. J.

DISTRICT OFFICES IN PRINCIPAL CITIES

CHEMICAL COMPOSITION AND ROAD ANTIKNOCK PERFORMANCE OF Possible Postwar Motor Fuels

JANE F. JORDAN
Technical Service Department, Ethyl Corporation, New York

NUMEROUS predictions have been made of the probable antiknock levels of postwar motor fuels. The consensus is that regular grade gasoline will be in the neighborhood of 78 to 80 octane number, ASTM Motor method, and that premium-grade fuel will be around 83 to 85 octane number ASTM. Whatever the ultimate levels, postwar motor fuels will be in many respects like their prewar predecessors, consisting of blends of various refinery stocks and tetraethyl lead.

However, to evaluate these postwar motor fuels solely in terms of their indicated laboratory octane numbers can be distinctly misleading, as this paper proposes to show. Moreover, as will be demonstrated, it does an injustice to the great stride taken in refining technology during the war — which not only has seen the advent of new and improved refining techniques, but has also brought, as a corollary, a greater facility in varying the chemical composition of fuels.

This is borne out by reference to prewar refining experience. Then, the exact composition of a final blend was governed by the necessity of achieving a definite laboratory octane value. Yet it is a familiar fact that fuels of the same octane rating often differ markedly in their performance on the road. If this was apparent before the war, it doubtless will become much more pronounced after the war, when a wide variety of chemical compositions will be possible. As a result of investigations into the road performance of a large number of motor-fuel blends, it is believed that the variations of chemical composition with respect to the boiling range of the fuels is of particular importance.

The advances in refining techniques during the war have placed at the disposal of the oil industry more means of varying the chemical composition of motor fuels than ever before. Prewar motor-fuel-blending stocks were limited, in general, to natural, straightrun, thermally-cracked, and polymer gasolines, and tetraethyl lead. After the war, the industry will have at hand the additional components of heavy alkylate, catalytically-cracked, hydroformed, superfractionated, and isomerized gasolines. That being the case, it is interesting to consider some of the possibilities for varying chemical composition which these conponents offer, and more especially, the effect such variations will have on the road antiknock performance and road lead susceptibility of the resultant fuels.

THIS discussion proposes to show the greater meaning of actual road antiknock performance of motor fuels over their indicated laboratory numbers. More, it tends to demonstrate that greater possibilities for improving fuel performance are possible with recent refining methods than have been realized to date. Greater awareness of the implications of the newer refining methods for improving road antiknock characteristics of motor fuels will permit selection of equipment which will complement existing facilities.

Because of its timeliness editors of Industrial and Engineering Chemistry granted permission to present this paper prior to a report of the review committee, whose recommendations may be incorporated in any additional publication. The paper is printed here as presented before the petroleum meeting of the Wichita Section of the American Chemical Society, Wichita, Kansas, May 17, 1945.

The Borderline Knock-Test Method

All of the road test work upon which this discussion is based was done by the Borderline Knock Test Method, adopted by the Cooperative Fuel Research Committee as a standard procedure in 1940. Previously, road testing of fuels had been carried out

by the CRF Uniontown method, in which the test fuels were bracketed on the basis of maximum knock intensity between secondary reference fuels of known octane number, very much as laboratory octane numbers are determined. As a matter of fact, the ASTM Motor method of laboratory knock testing was designed to give results which would correlate with those obtained on the road by the CFR Uniontown method. At the time the ASTM Motor method was adopted in 1932, it did a fairly good job; the fuels which did not fit its pattern were relatively few. However, the rapid developments in refining methods since that time have led to the production of more and more gasolines which show better antiknock performance in cars on the road than is indicated by their Motor method ratings in the laboratory. This has suggested the need for greater reliance upon road testings as a truer measure of antiknock quality. Consequently, a lot of study has been devoted to the development of improved knock-testing methods.

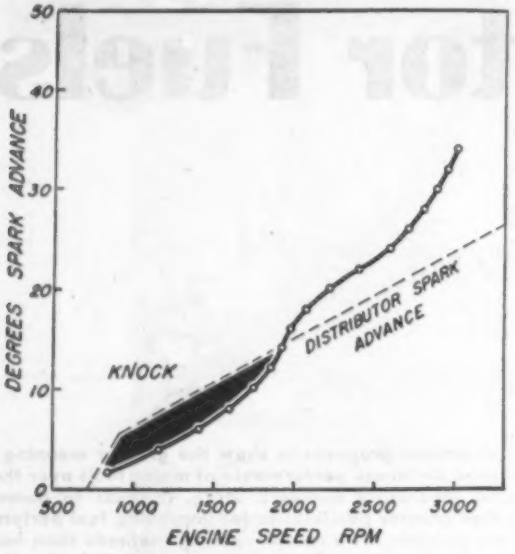


FIGURE 1

Borderline knock curves; method used to obtain curve for any fuel.

As a road test procedure, the Uniontown method has many uses. But for studying the effects of chemical composition on road antiknock performance, it has one great disadvantage. This is, that it rates fuels on the basis of knock intensity irrespective of the speed range in which the knock occurs. Thus, a straightrun and a cracked gasoline may both be assigned a road octane number of say, 80. Yet the typical curves of knock intensity versus engine speed will show that the straightrun fuel develops its maximum knock at low speeds, while the cracked gasoline develops maximum knock at high speeds. Furthermore, the Uniontown method gives an investigator no idea of the road antiknock characteristics of the test fuel in the speed range in which it doesn't knock, thereby limiting its usefulness.

The Borderline Knock method, on the other hand, gives more information of the type sought by automotive engineers and petroleum technologists. Whereas the Uniontown method assigns a single road octane number to a test fuel, the Borderline method indicates the road antiknock performance of a gasoline by means of a curve. This borderline knock curve shows graphically a fuel's ability to tolerate spark advance throughout the entire engine speed range. As its name implies, it represents the dividing line between knocking and non-knocking operation. For testing by this method, a test car is equipped with a fixed or non-automatic distributor that can be varied manually by the driver, a suitable spark advance indicator, and an engine tachometer.

The procedure for determining the borderline curve for a fuel is as follows:

The spark is set manually to a relatively low advance, usually 2 to 6 degrees before top dead center. The car is slowed down to as low a speed as possible in high gear, generally about 6 to 8 miles per hour, and then accelerated with wide open throttle. As the engine picks up speed, the knock intensity lessens, and the speed at which the knock dies out is noted. This gives one point on the borderline curve, representing the two dimensions on the chart; spark advance (vertical axis) and knock-die-out speed (horizontal axis). The spark is then advanced 2 degrees and the entire procedure repeated to obtain the second point on the curve. This process is continued until the complete curve has been established for the entire spark advance and speed range under consideration.

Borderline test data usually are plotted as shown in Figure 1. The light dotted line represents the distributor spark advance curve for the particular engine in which these tests were conducted. For a fuel not to knock in this car, it must be able to tolerate at least as much spark advance at all speeds as that normally produced by the distributor-advance mechanism. Wherever the solid line representing the borderline curve for the test fuel falls below the distributor-spark-advance curve, the engine is considered to be knocking. The borderline curve for the fuel in question indicates that it will knock at relatively low speeds in the range from 700 to 1800 revolutions per minute. In this example, the actual knock-die-out points, obtained on the road, are indicated by the heavy dots to illustrate the number of points obtained in the development of a curve of this type. The individual points are not shown on the borderline curves subsequently presented, but they are all obtained and recorded in a similar manner.

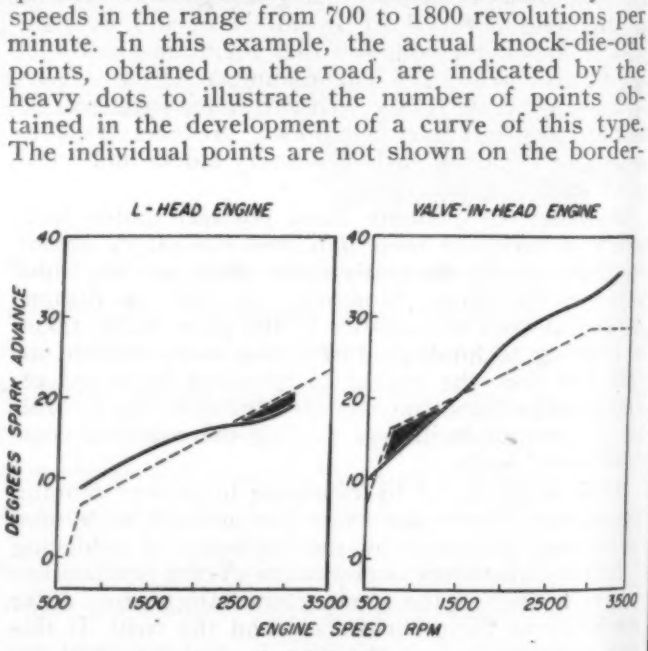


FIGURE 2

Borderline knock curves for blended gasoline in L-head and valve-in-head engine.

It should be pointed out that the borderline curves, obtained by this procedure, are indicative of the antiknock characteristics of the test fuel only in the particular engine in which the tests were conducted. Engines, too, differ in their knocking tendencies. In

general, the valve-in-head engine is inclined to knock more at low speeds than the L-head engine, while the latter generally knocks more severely in the higher speed ranges. This is demonstrated in Figure 2 which shows borderline curves of the same test fuel determined in the two types of engines. Because of this variation in engines, it is advisable to determine the borderline curves of test fuels in at least one and preferably duplicate engines of each type. The present work was done in representative engines of both types. Many of the curves used are presentations of

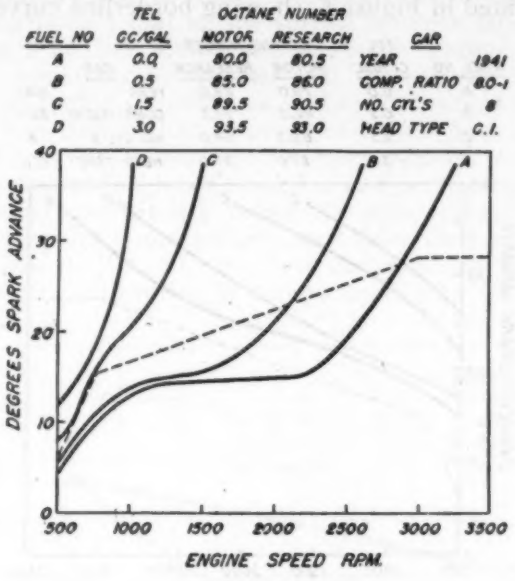


FIGURE 3

Borderline knock curves; saturated type gasoline, showing road lead susceptibility.

the data from one car or the other only. But this has been done merely to simplify the discussion and to stress the essential fuel characteristics which are the particular point of interest here.

Fundamental Variations in Fuel Types

Using the borderline method, it is possible to demonstrate the fundamental differences in the road antiknock characteristics of the various fuel types. Take, for example, a saturated type fuel which is similar chemically to the straightrun gasolines marketed before the war. Borderline curves for this fuel, clear and with three different concentrations of tetraethyl lead, are shown in Figure 3.

On the basis of improvement in laboratory octane numbers, this gasoline is very susceptible to tetraethyl lead. The addition of 3 c. c. of lead per gallon raises the Motor method octane rating 13.5 numbers. On the road, however, the principal effect of the TEL addition is to improve the high-speed performance of the fuel out of all proportion to the improvement gained at low speeds. Since the saturated type fuel is inherently good at high speeds and deficient in antiknock quality at low speeds, the tetraethyl lead is of relatively small benefit — measured in actual road performance — in spite of the excellent boost it promises from laboratory octane ratings. This is shown by the almost perpendicular character of the borderline curves of the leaded fuels.

At the same time, as an inspection of Figure 3 shows, a satisfactory fuel — that is one which will satisfy the spark advance requirements of the engine over the entire speed range — can be made by the addition of a little more than 1.5 c. c. of tetraethyl lead per gallon, probably 1.6 c. c. This is indicated by Curve C which lies above the distributor-spark-advance curve at all speeds above 800 revolutions per minute. Such a fuel would rate about 90 octane number by both the Motor and Research methods, since this is what is normally termed an "insensitive" type of gasoline.

In contrast, Figure 4 presents the borderline curves, clear and with the same concentrations of tetraethyl lead as in Figure 3, of a highly unsaturated type of gasoline. In terms of laboratory octane rat-

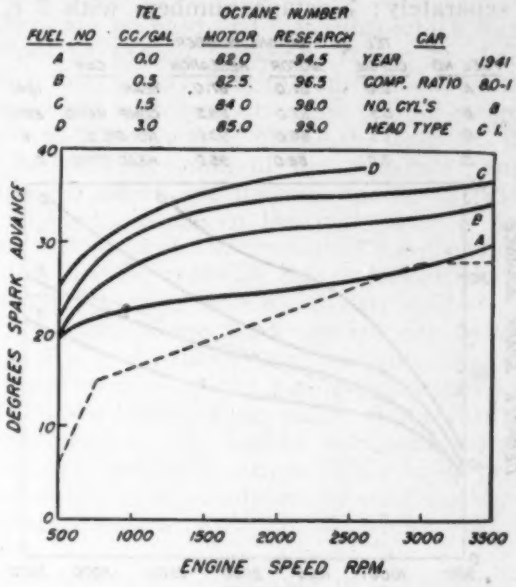


FIGURE 4

Borderline knock curves; unsaturated type gasoline, showing road lead susceptibility.

ings, this is a very "sensitive" gasoline — showing a spread of 12.5 octane numbers between its Motor and Research method ratings. At the same time, it has very poor lead susceptibility. The addition of 3 c. c. of lead to this fuel raises its antiknock value by only 3 laboratory octane numbers.

Nevertheless, this gasoline is more suitable for the engine than the saturated type of fuel — despite its tendency to knock in the high-speed range. As with the saturated fuel in Figure 3, the addition of tetraethyl lead to this unsaturated fuel improves its high speed performance. But since, in this case, the fuel is inherently good at low speeds and weak at high speeds, the TEL is now complementing the natural properties of the gasoline. More than that, it demonstrates that the gain in road performance — where it is needed — may be more important than the small gain in laboratory octane numbers would indicate. A satisfactory fuel for the engine could be made from this unsaturated stock with the addition of a very small amount of tetraethyl lead: about 0.2 c. c. per gallon. The resulting fuel would have a Motor method rating of about 82.5 and a Research rating of about 95.

It is obvious that, technically, a more suitable fuel than either of the foregoing would be one with a borderline curve which was parallel and slightly above the distributor-spark-advance curve of the car throughout the speed range. This would insure knock-free operation at all speeds without "wasting" antiknock quality at any speed. It may be more economic, of course, to produce a fuel like those shown in Figures 1 and 2 with "excessive" antiknock value in some part of the speed range. The possibility of

blending the saturated and unsaturated type stocks—in order to take advantage of the inherently low-speed characteristics of the latter and the inherently good high-speed characteristics of the former — immediately comes to mind.

Borderline curves for such a fuel, a 50-50 blend of the two previously illustrated stocks, clear and with various concentrations of tetraethyl lead, are shown in Figure 5. The tetraethyl lead susceptibility of this combination of gasolines, by laboratory knock-testing methods, is about the average of the two stocks taken separately; 7 octane numbers with 3 c. c. of

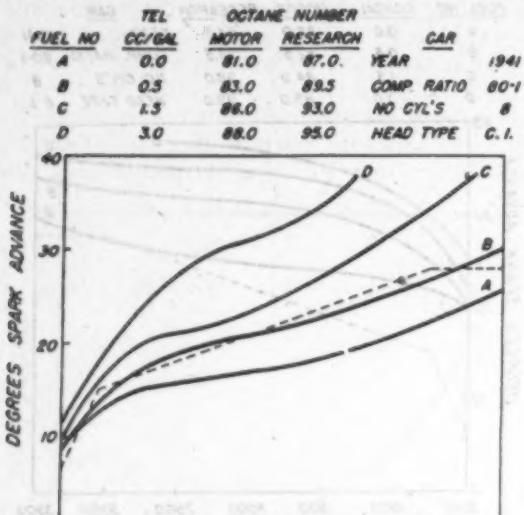


FIGURE 5

Borderline knock curves; blended gasoline, 50 percent saturated, 50 percent unsaturated, showing road lead susceptibility.

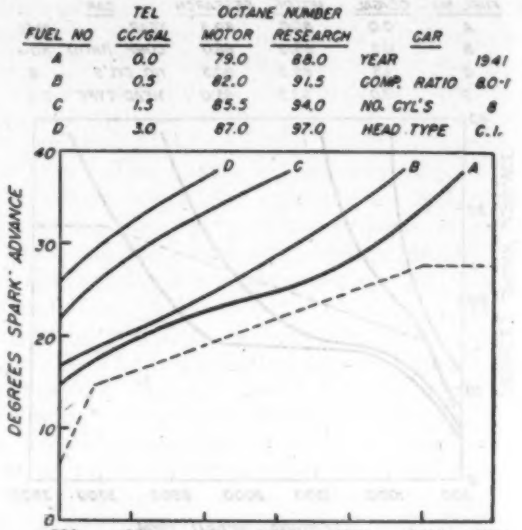


FIGURE 6

Borderline knock curves; selectively blended gasoline, showing road lead susceptibility.

lead. The road response is more "even" than for either stock alone, although here again there is a definite tendency to effect more improvement at high speeds than at low speeds, especially with high tetraethyl-lead concentrations. The addition of about 0.7 c. c. of tetraethyl lead to this blend results in a fuel which will satisfy the distributor-spark-advance requirements of the test car thoughout the speed range. This fuel has a Motor method rating of about 85 and a Research rating of about 90 octane number.

Road antiknock curves obtained on a number of commercial gasolines prior to the war indicate that the average prewar fuel was a good deal like the foregoing 50-50 blend in sensitivity, lead susceptibility, and road performance. In general, these fuels tended to knock at low speeds, so that it appears reasonably accurate to state that an improvement in the low-speed antiknock characteristics of fuels is generally desirable. This statement must be qualified by adding, "for the present type of naturally aspirated gasoline engine." Obviously, engine developments in the postwar period, which will alter the fuel requirements of the engines, are quite possible.

For example, the effect of a new type transmission, which would prevent loading the engine below 1500 revolutions per minute, cannot be discounted. Such a development would make low-speed antiknock quality relatively unimportant. Similarly, supercharging may be expected to influence the relation of fuel type to engine requirement. Such possibilities are outside the scope of this discussion, but they should be kept in mind. It is reasonable to expect, however, that for a period of years after the war, there will be large numbers of the present type of gasoline engine on the road, and the statements made here are generally applicable to them.

This desired improvement in low-speed antiknock performance — and the achievement of a better "fit" in general between engine and fuel — can be accomplished by controlling the distribution of hydrocarbon type with respect to the distillation range of the blend. The variety of new fuel types made available during the war permits innumerable combinations in which this can be done. One such "special blend" is illustrated in Figure 6, showing borderline curves for the fuel, clear and with various additions of tetraethyl lead. Such a fuel not only conforms nicely to the distributor-spark-advance curve of the car in the unleaded state, but the addition of tetraethyl lead effects an almost uniform improvement in both low and high speed antiknock quality, so that this conformity is retained at all octane levels. In this case, the unleaded fuel, having a Motor method rating of about 79 and a Research rating of about 88 octane number, is entirely satisfactory for the car.

It is interesting to review the antiknock characteristics of the four fuels just discussed:

Type of Gasoline	OCTANE NUMBER	
	ASTM Motor	CFR Research
Saturated	90.0	90.0
Unsaturated	82.5	95.0
50-50 Blend	85.0	90.0
Special Blend	79.0	88.0

Here are four fundamentally different fuels. They vary by as much as 11 octane numbers by the laboratory Motor method. In consequence, one would have superficially expected a wide variance in their road antiknock performance. But as the foregoing discussion tried to show, these four different fuels have *essentially comparable* road antiknock performance—as judged by their ability to satisfy the distributor-spark-advance requirement of the engine. In other words, with the proper combination of blending stocks and tetraethyl lead, it is possible to produce a fuel, like the special blend of only 79 Motor-method octane number, that has better road antiknock

performance — throughout the speed range — than a fuel of higher Motor-method ratings like the saturated fuel of 90 octane number. This, then, should demonstrate the fallacy in blending to a given laboratory octane number, as a criterion of fuel quality, without full appreciation of the inherent road antiknock characteristics of the particular blend.

Sensitivity as a Criterion of Fuel Quality

It is sometimes thought that the principal factor of importance in road antiknock performance is "sensitivity"; that is, the spread between laboratory ratings by the Motor and Research methods. It is only necessary to consider that the special blend in the preceding illustrations — the most satisfactory of the four fuels — has a spread of only 9 octane numbers between Motor and Research ratings while the unsaturated fuel has a spread of 12.5 octane numbers; obviously, sensitivity is not the sole explanation.

This point is particularly well illustrated in Figure 7. Fuels A, B and C are three commercially possible motor fuels all rating 80 octane number by the Motor

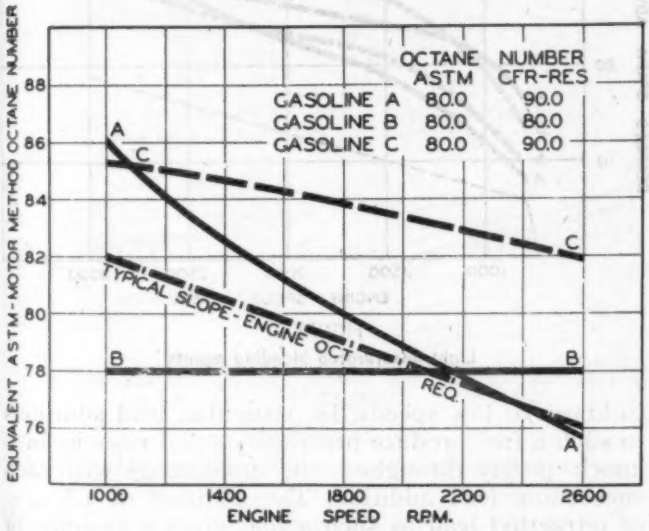


FIGURE 7

Variation in equivalent ASTM octane number with engine speed.

method. Fuel B is an "insensitive" type, such as straightrun gasoline. Fuels A and C are "sensitive" gasolines showing a spread of 10 octane numbers between Motor and Research ratings.

The three fuels perform very differently on the road. The dot-dash line of typical slope of engine octane requirement was constructed from numerous data on heavy-duty commercial-type engines. It illustrates the well-known fact that the average engine requires a better fuel, in terms of octane number, at low engine speeds than it does at higher speeds. Here, engine octane requirement, in terms of Motor-method octane number, is approximately 82 at 1000 revolutions per minute while at 2600 revolutions per minute a fuel of about 76 is adequate. The insensitive fuel B rates about 78 octane number throughout the engine speed range, that is, slightly below its Motor-method octane number. Since this is considerably below the requirement of the average engine illustrated at speeds up to 2000 revolutions per minute, an 80 octane, Motor method, gasoline of this type probably will knock excessively in an average engine destined to run on 80-octane fuel. This is because Fuel B happens to be a kind which does not show up well on the road. Fuel A is typical of the customary "sensitive" type gasolines. It has excellent low-speed antiknock characteristics, but tends to knock slightly in the higher speed ranges above 1900 revolutions per minute. Fuel C, however, is a specially blended "sensitive" type fuel. On the road it has much better antiknock qualities over the entire speed range than Fuel A, and, in particular, does not break down at high engine speeds.

Special Blending: Effect of Type of Light Blending Materials

There are no hard and fast rules which dictate the methods of special blending. It can be defined no further than to say it is the adjustment of chemical composition with respect to the boiling range of the fuel in such a way as to obtain the best "fit" between the fuel requirements of the particular engine or engines in which the investigator is interested and the engine response of the fuel. Over a period of years, and through the testing of hundreds of different fuel blends, some of the factors in the process of special blending have been fairly well established. On the basis of the work carried out by our own laboratory, it is believed that one important factor is the concentration of the highly unsaturated components in the light-boiling range of the fuel and the concentration of the highly saturated materials in the heavier-boiling fractions. This is of prime importance from the standpoint of road antiknock performance, which, after all, is where fuel quality counts.

The importance of the type of light blending material is shown in Figures 8 and 9. This series of fuels was prepared, using as a base a regular grade gasoline containing approximately 70 percent of high-pressure thermally-cracked gasoline and 30 percent of low-endpoint straightrun gasoline from Illinois crude oil. This base fuel was stripped through the C_5 fractions, the material removed constituting about 19 percent of the total fuel. To 81 percent of the stripped base were then added 19 percent of each of the light blending agents tested. Road and laboratory knock ratings were made on the fuels, clear and with additions of 0.5, 1.5 and 3.0 c.c. of tetraethyl lead per gallon. The borderline curves given here show only the fuels containing 3 c.c. of lead, primarily for simplification, and also because this discussion is concerned with possible postwar fuels. Similarly, data are shown for only one car, although ratings were obtained in both a valve-in-head and L-head engine. This work was carried out in cooperation with the Pure Oil Company and the author is indebted to that company for permission to use the data obtained.

The light paraffinic agents (Figure 8) effect changes in the road antikock characteristics of the base fuel, which are roughly in line with the indicated changes in laborartory octane number. Thus, substitution of *n*-pentane drops the Motor method rating of the base fuel about 2.5 octane numbers, and there is a corresponding derating on the road. Conversely, isopentane and neohexane improve the laboratory ratings of the base somewhat, and the road ratings of these blends are as good or slightly better than that of the base fuel. In all cases, however, the borderline curves of the blends parallel the borderline pattern of the base fuel.

The substitution of the olefinic blending agents, on the other hand, (Figure 9), makes a marked improvement in low-speed antiknock performance of

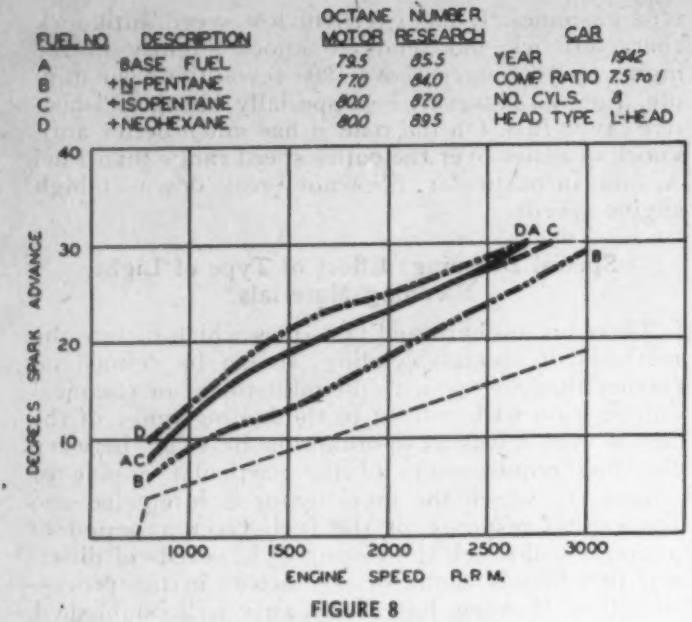


FIGURE 8

Light saturated blending agents.

the base fuel. The normal olefin is less effective than the highly branched trimethylethylene, of course, which is in keeping with the general superiority of branched-chain compounds over their straight-chain isomers. As a result of the improvement in low-speed performance, the over-all borderline curves tend to parallel the distributor-advance curve. Thus, it would be possible to advance the basic timing by about 9 degrees and yet have this engine operate satisfactorily on the fuel containing trimethylethylene.

It is particularly interesting, and not immediately explainable, that cyclopentane proves to be one of the best low-speed antiknock agents of all the C_5 and C_6 hydrocarbons tested in this series. Although it is a naphthene, and thus would be expected to act more or less as the paraffins do, it actually has the same type of effect on low-speed performance as an olefin. It is almost as good at 1000 revolutions per minute as trimethylethylene. The curves in Figure 9, being for one lead concentration only, do not demonstrate the advantages of light olefinic type materials in improving low-speed lead susceptibility as well as low-speed antiknock performance. Actually, here as in all cases investigated to date, these effects occur simultaneously.

Using this principle of concentrating unsaturated material in the front end and saturated components in the heavy end, the best fuel made in the laboratory up to the present time is shown in Figure 10. This fuel contains 50 percent of vapor-phase-cracked gasoline boiling up to about 275° F. and 50 percent of heavy alkylate having a boiling range of approximately 300 to 400° F. Here, for the first time, are shown all the curves obtained in road testing such a fuel. The borderline data obtained in the L-head and the valve-in-head engines are shown side by side. The maximum power spark-advance curve is shown, as well as the distributor-spark-advance curve, the former by the dot-dash line, the latter by the dotted line. The light solid lines in the background give the secondary reference fuel pattern, the Motor-method octane number of each being shown at the end of the line. It is possible to interpolate between them and determine the road octane number of the test fuels at any given engine speed, if this is considered advantageous. As a practical matter, the reference fuel pattern is simply a standard for judging the reasonableness of the test results obtained on any given day and a check on the "normalcy" of the engine itself.

It will be noted that the borderline curves of this special blend, with and without the addition of tetraethyl lead, parallel the distributor and the maximum-power spark-advance curves of the cars. This is true even in the valve-in-head engine, which tends

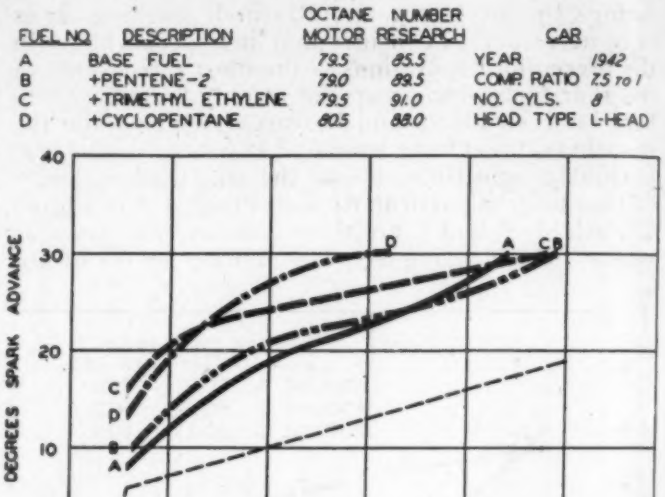


FIGURE 9

Light unsaturated blending agents.

to knock at low speeds. In particular, lead additions to such a fuel produce practically equal rises in antiknock quality throughout the speed range with each succeeding lead addition. The addition of 1.5 c. c. of tetraethyl lead to such a fuel gives a gasoline of about 85 Motor-method and 94 Research-method octane rating. This has sufficient antiknock performance throughout the speed range to permit the spark to be advanced to maximum power spark setting in both the L-head and valve-in-head engines of 8.5 and 8.0 to 1 compression ratio, respectively.

Similar fuels almost as good as the vapor-phase-

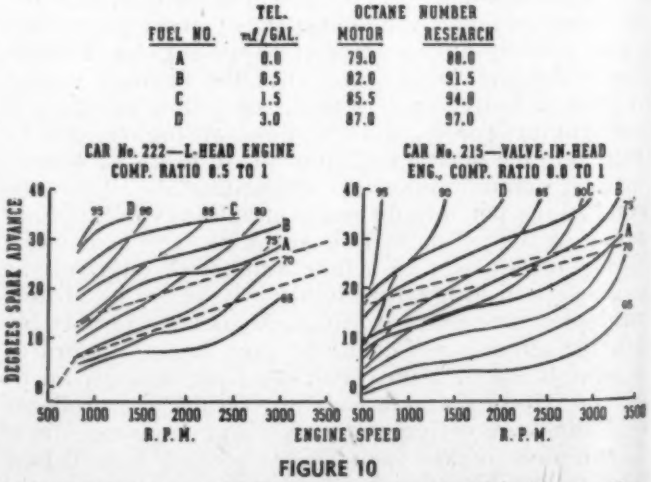

FUEL NO.
TEL. ml/GAL.
OCTANE NUMBER MOTOR
RESEARCH
A 0.0 79.0 88.0
B 0.5 82.0 91.5
C 1.5 85.5 94.0
D 3.0 87.0 97.0
CAR No. 222—L-HEAD ENGINE COMP. RATIO 8.5 TO 1
CAR No. 215—VALVE-IN-HEAD ENG., COMP. RATIO 8.0 TO 1
DEGREES SPARK ADVANCE
ENGINE SPEED R. P. M.

FIGURE 10

Borderline knock curves; 50 percent vapor-phase cracked gasoline, initial boiling point to 275° F.; 50 percent heavy alkylate.

cracked-heavy-alkylate blend have been made by blending 275° F. endpoint vapor-phase-cracked gasoline with heavy naphthenic straightrun gasoline and heavy hydroformed gasoline. All of these fuels show the same tendencies, but, in general, the isoparaffinic heavy material is best, the alkylated aromatic material present in heavy hydroformed stock next and the naphthenic material least attractive of the three.

Special Blending: Effect of Olefins in the High-Boiling Range

A second general principle of special blending appears to be that the presence of olefinic material in the heavy end of the fuel not only affects high-speed antiknock performance but also has a deleterious effect on low-speed lead susceptibility.

This is demonstrated in Figures 11 and 12. In Figure 11 are shown the borderline curves, with and without tetraethyl lead, of a first-pass catalytically-

FUEL NO.	TEL. ml/GAL	OCTANE NUMBER MOTOR	RESEARCH
A	0.0	77.0	90.0
B	0.5	79.5	92.5
C	1.5	83.0	94.5
D	3.0	84.5	96.0

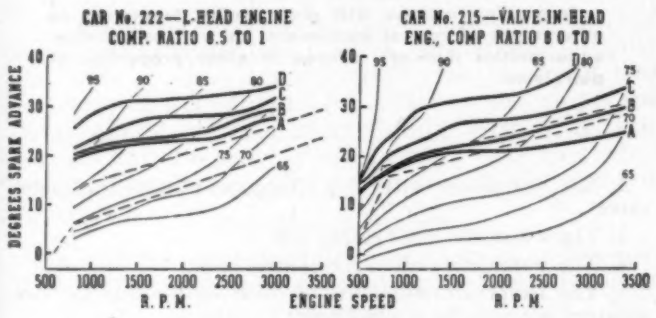


FIGURE 11

Borderline knock curves; 100 percent catalytically-cracked gasoline.

cracked gasoline. It is a cat-cracked fuel made rather early in the development of the process; for that reason, it may not be typical of the catalytically-cracked materials which will be made when these units are converted to motor-fuel production in the postwar period. The curves indicate a tendency to knock at high speeds and a relatively good low-speed antiknock performance typical of the unsaturated type gasoline. The low-speed lead susceptibility of this fuel is not particularly good. Figure 12 presents the borderline curves of this same catalytically-cracked fuel in which the last 10 percent of the gasoline has been replaced with 10 percent of 300-400° F.-boiling-range heavy alkylate. The substitution of saturated for the unsaturated components in this portion of the boiling range has improved lead susceptibility throughout the speed range and has produced a fuel more nearly paralleling the distributor-spark-advance curve of the cars.

It is interesting to compare these catalytically-cracked base fuels with the thermally-cracked base fuel shown in Figure 10. The same amount of tetraethyl lead is required in the 100 percent catalytically-cracked gasoline, 1.5 c. c. per gallon, to produce a fuel satisfactory for the two types of engines as was required for this purpose by the vapor-phase-alkylate blend. Such a fuel rates 83 Motor method, and 94.5, Research method. It is more sensitive than the thermal-base blend, but the latter is a much better fit for the engine and allows a more comfortable cushion of performance. The substitution of 10 percent of heavy alkylate in the high-boiling range, however, permits the production of a satisfactory fuel from the catalytically-cracked gasoline with the addition of only 0.5 c. c. of tetraethyl lead per gallon.

FUEL NO.	TEL. ml/GAL	OCTANE NUMBER MOTOR	RESEARCH
A	0.0	80.0	91.0
B	0.5	82.5	95.0
C	1.5	84.5	96.5
D	3.0	85.5	97.5

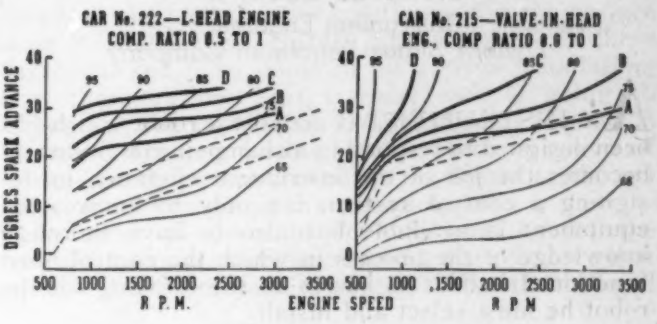


FIGURE 12

Borderline knock curves; 90 percent catalytically-cracked gasoline, approximately 300° F. end point, 10 percent alkylate, approximate boiling range 300 to 400° F.

Obviously, commercial fuels cannot be made by cutting up the various refinery stocks, using the desirable portions, and throwing the rest away. There are, however, some general ways in which improvements can be made in average fuels to alter their composition so that they tend to approach the type of fuel whose borderline pattern parallels the distributor-spark-advance curve of the average automotive engine. For example:

1. By substituting a small amount of high-boiling paraffinic, naphthenic, or aromatic material for the high-boiling olefinic hydrocarbons normally contained in highly cracked fuel.
2. By adding light olefinic or aromatic material to a straightrun fuel.
3. By blending refinery stocks with due consideration to the effect of such blending on the road lead susceptibility of the fuel throughout the speed range, so that the maximum advantage is obtained from the lead additions.
4. By using light olefinic material rather than light paraffinic material to adjust volatility.

Even better from the point of view of use of these principles in full-scale plant operation would be the discovery of some means of making it practical to cut saturated and unsaturated type stocks in half, and deolefinize the heavy unsaturated material and dehydrogenate the light saturated material before recombining them. This, of course, is expensive. But with the advances in refining technique in these past war years as tools, such a possibility is not altogether far-fetched.

This discussion has attempted to show the greater meaning of the actual road antiknock performance of motor fuels over their indicated laboratory numbers. More, it has demonstrated, it is hoped, that greater possibilities for improving fuel performance are possible with recent refining methods than have been realized to date. At the very least, greater awareness of the implications of the newer refining methods for improving the road antiknock characteristics of motor fuels will permit the selection of new equipment which will complement existing plant facilities.

Functions and Fundamentals of Temperature in Refinery Process Control

DAVID M. BOYD, JR.
Instrument Engineer,
Eastern States Petroleum Company

BASICALLY instrumentation is the control of a product by its physical properties. At present only two of these properties—temperature and pressure—are being extensively used in refining. It is evident that many additional properties that can be used, such as refractive index, absorption spectra, and dielectric property.

Some separations in refinery processing must be made on such slight changes in temperature that it seems logical that one or more of these other properties may offer much better approach to proper control.

It is the purpose of this paper to trace the development of temperature process control and to give a few examples of problems encountered in the design and operation of a 100-octane gasoline plant, which requires more than 300 instruments.

Succeeding articles will give similar treatment to other types of control instruments as well as examine opportunities that are offered in other properties of petroleum.

AN INSTRUMENT is actually a robot which has been designed to respond to a change in conditions. It becomes the job of the instrument engineer, in designing a control system, not only to know what equipment is available but also to have thorough knowledge of the process in which the control must function. In effect he has to do the thinking for the robot he must select and install.

Batch Process

In considering the fundamentals of control through temperature changes, let us consider the problem of heating a kettle of water and maintaining it at a given temperature. A constant supply of water is required in some refining process and its temperature must be 180° F. This can be done by providing two kettles, each of 200 gallons capacity, each equipped with steam coils, Figure 1. The water from one kettle can be used while water in the other is being heated.

Such a process would have a large heat-storage capacity and the temperature change would be relatively slow. Figure 2 shows the temperature change plotted against time as the water is being heated. The curve will have a slope α depending upon: (1) the steam pressure in the coil, (2) the heat-transfer surface, (3) the heat capacity of the system. The cooling curve for this system is shown in Figure 3. The slope of this curve β, is dependent upon: (1) the amount of surface exposed to the atmosphere, (2) the amount of insulation, (3) the heat capacity of the system.

This process requires the simplest type of control because of its large capacity and relatively small volume on the steam side. Such a controller would open the steam valve when the temperature went below 180° F. and close it when the temperature went above 180° F. The controller is cycling on and off all the time.

The operation of such a controller requires a certain time and the heating or cooling of the water takes another length of time. The time of the cycle is made up of the following items:

1. The temperature-sensitive element senses that the temperature is below the control point.
2. The instrument notes this change and opens the control valve.
3. The steam fills the heating coil.
4. The water heats up to the control point.
5. The temperature-sensitive element senses that the temperature is above the control point.
6. The instrument notes this change and closes the control valve.
7. The remaining steam in the coil is consumed.
8. The water cools to below the control point and step 1 is repeated.

Figure 5 shows operation of an on-off controller that has no mechanical hysteresis losses in its action. In other words it acts at the same control point whether the temperature is rising or falling. From this we see that the temperature of the water or controlled medium is actually rising or falling all the time. The amount that it rises or falls depends upon the slope of the time-temperature curves for heating and cooling (Figures 2 and 3) and the time required for the controller to act, steps 1, 2, 3, 5, 6, and 7 of Figure 5.

A process with a large heat capacity will have a low slope on its heating and cooling curves, and will be easy to control providing the time required for the controller to act is not excessive. The large heat capacity acts much the same as a flywheel on an engine, and makes this type of batch process easy to control.

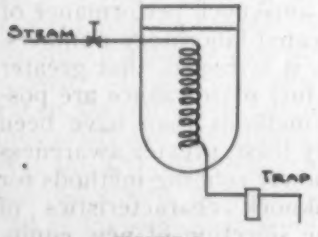


FIGURE 1
Water-heating kettle

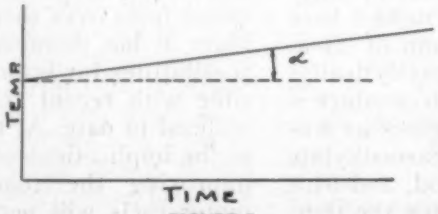


FIGURE 2
Heating with steam valve open

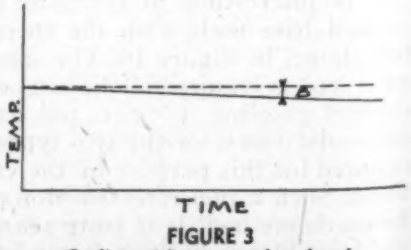


FIGURE 3
Cooling with steam valve closed

within fairly close limits, using the simplest type of controller.

Semi-Batch Process

Suppose the plant has had a change that requires a larger amount of hot water. It could be obtained by installing more heating kettles or by drawing the water off the kettle as it is being added to the kettle and heated. The latter method requires the smallest

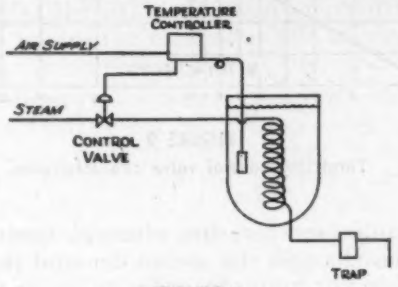


FIGURE 4
Water-heating kettle with simple control system

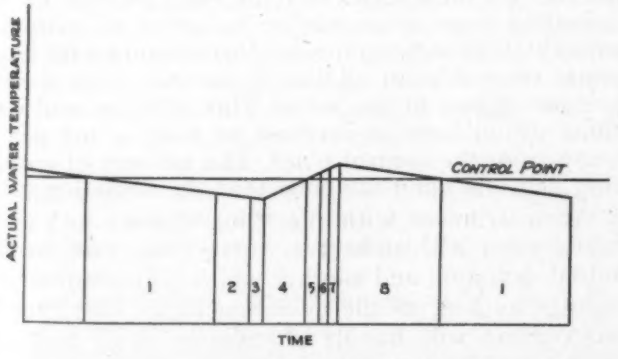
capital expenditure. The only additional cost involved is for a float-operated level controller to maintain a level in the kettle by controlling the water coming in.

As long as the ratio of water leaving the vessel is low compared to the total volume. The heating and cooling curves for this process will be substantially the same as those for the batch process except that the heating curve will have slightly less slope and the cooling curve will have slightly more slope. For this reason, the process will be very easy to control and the simplest on-off type control should be used.

Continuous Process

Should the plant need an added supply of hot water, more than the present heating surface could supply, a heat exchanger to heat the water and a controller to maintain the proper outlet temperature would be indicated as shown in Figure 7.

The heating curve for this system is very much steeper than the curve for the batch or semi-batch system, see Figure 8. If the old type of on-off controller were used on this system the water temperature would cycle over a very wide range due to the time consumed in steps 1, 2, 3, 5, 6, and 7 of the controller cycle and the very short time of steps 4 and 8. In other words, temperature of the water



STEP	DESCRIPTION
1	BULB TEMPERATURE FALLS BELOW CONTROL POINT
2	INSTRUMENT OPEN CONTROL VALVE
3	COIL FILLS WITH STEAM
4	WATER HEATS TO CONTROL POINT
5	BULB TEMPERATURE RISES ABOVE CONTROL POINT
6	INSTRUMENT CLOSES CONTROL VALVE
7	STEAM IN COIL IS CONSUMED
8	WATER COOLS TO CONTROL POINT

FIGURE 5
Controller operating cycle

would be considerably above or below the control point before the instrument could note the change and compensate for it.

This type of process calls for a redesign of the controller so that it will throttle the steam instead of turning it on and off. The throttling action of the controller in effect decreases the slope of the heating and cooling curve.

In studying the factors affecting the slope of the heating curve it is best to go back to our heat transfer equation:

$$Q = UA\Delta T$$

The total heat transferred Q is directly proportional to the heat-transfer coefficient, U; the surface area, A; and the temperature difference, Δ T. Of these factors U and A are constant for a given installation, and therefore the heat transfer rate is going to change as the condensing temperature of the steam changes. This condensing temperature is governed by the control valve throttling the steam to the exchanger and reducing the pressure.

In order to maintain smooth operation of the system, manufacturers developed a control valve that gives equal percentage increases of flow with equal

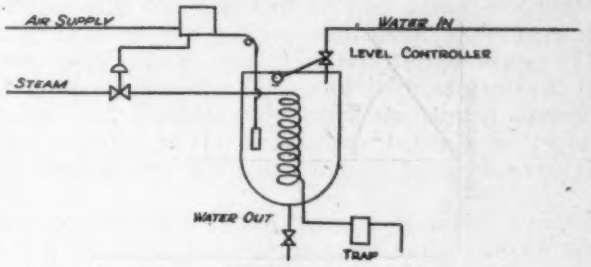


FIGURE 6
Semi-batch controller

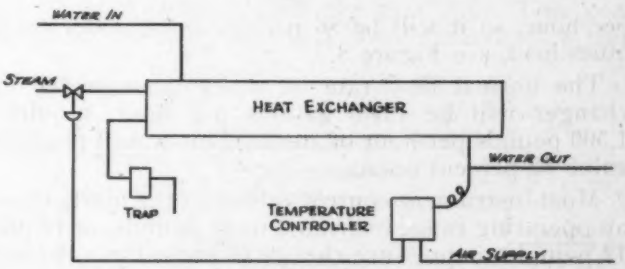


FIGURE 7
Continuous process controller

increments of lift, or pressure from the instrument controller. Such a valve will plot a straight line on semi-logarithmic paper if flows are plotted on the logarithmic scale and lift is plotted on the uniform scale.[1] These valves were developed and are known as "V" port or parabolic plug types, depending upon the construction of the inner valve. See Figure 9.

Most important is selection of the control valve. This is especially true in the question of size.

In the case of the continuous water heater the maximum amount of steam to be used is limited by the surface area of the heat exchanger and the pressure of the available steam supply. The control valve should be so sized that it will pass this amount when it is wide open, and thus control the process throughout its range.

Manufacturers supply accurate tables for use in selecting the proper valve size for the particular job in hand, which makes this comparatively simple if

[1] "Principles of Controlled Valve Reactions," C. E. Mason, The Foxboro Company.

the fundamental information as to capacity and pressure drop is accurate. In designing an installation it is best to allow a 10 percent pressure drop in the control valve at maximum capacity.

Study of the action of a throttling type of controller requires definite figures as to the changes involved.

The water is flowing at a maximum rate of 2,000 gallons per hour. It enters at 65-95° F. and leaves at 180° F. This is a total heat transfer rate of 1,910,000 Btu per hour.

The available steam supply is 10 pounds gauge, or 25 pounds absolute. Allowing 10 percent drop across the control valve gives 22.5 pounds absolute, inside the tubes of the exchanger, or 234° F. This gives an MDT of 100° F. Assuming a heat-transfer coefficient of 100 we find that we need a surface area of 191 square feet.

The exchanger will use 2,000 pounds of steam per hour at maximum load. The pressure drop was to be 10 percent of the absolute pressure, or 2.5 pounds. A valve-sizing rule indicates the valve to be 3.2-inch, or taking the next larger valve size it would be 4-inch. The 4-inch valve would handle 3,000 pounds of steam

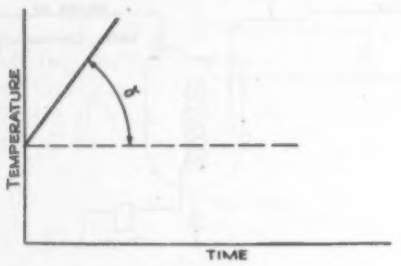


FIGURE 8
Continuous-process heating curve with steam valve wide open

per hour, so it will be 86 percent open under maximum load, see Figure 8.

The normal flow rate of water through the exchanger will be 1,500 gallons per hour, requiring 1,500 pounds per hour of steam. This would place the valve 82 percent open.

Most instrument control valves on the market have an operating range of from 3 to 15 pounds, or require 12 pounds air pressure change to move them through their operating range. They either open or close with an increase of air pressure from the instrument depending upon which action would be the safest in case of an air failure. The water heater uses a control valve that opens as the air pressure increases. The valve therefore would have approximately 13 pounds of air on the diaphragm to place it 82 percent open.

The throttling type of controller causes the air to the control valve to change as the pen deviates from the control point. In our case the sensitivity is set so that the air to the control valve changes at the rate of 9 pounds per inch of pen movement of the chart. The chart range is 0-300° F., even graduation, and amounts to about 100° per inch. Therefore, pen movement of 11° F. will change the air to the valve approximately 1 pound.

With the above information in mind, let us check the operation of the system. The inlet temperature is 65° F., the outlet temperature is 180° F., and the flow rate is 1500 gallons per hour. If all of these conditions remain the same, there would be no need for a controller to be installed, but if they change the controller is needed to compensate for them. In our

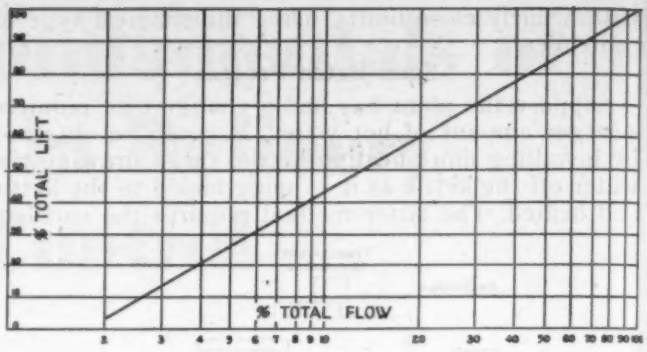


FIGURE 9
Throttling control valve characteristics

case, the inlet temperature changes from 65° F. to 95° F. This changes the steam demand from 1500 to 1110 pounds per hour. In order to make this change in steam flow the control valve would have to go from 82 percent open to 75 percent open or the air pressure on the diaphragm would have to change from 13 pounds to 12¼ pounds. In order to change the output air pressure this amount, the temperature would have to rise approximately 8°.

This brings to light the chief defect of the throttling type of controller, the necessity of having to deviate from the control point in order to get a controlling action. The amount that the controller will deviate depends upon the setting of the sensitivity or throttling range. The narrower the throttling range, or higher the sensitivity, the less will be the deviation from the control point as the load changes. Naturally it is desirable to set the sensitivity of the controller as high as possible in order to keep the deviation as small as possible. This is limited by the controller becoming unstable if the sensitivity becomes too high, and swinging on and off instead of throttling as it is intended to do.

The on-off controller does not drift away from the control point as the load changes, and for this reason they are the most satisfactory for use on the control jobs they can handle. However, in control jobs that have a comparatively short time during step 4 and 8 as compared to steps 1, 2, 3, 5, 6 and 7, it is impossible to use an on-off controller because it will overshoot the control point too far before the controller can act. In these cases it is necessary to go to the throttling type of controller in order to maintain smooth operating conditions. Instruments with automatic reset add an additional correction to the air pressure going to the valve. This addition will continue to build up or decrease as long as the pen is away from the control point. The amount of correction depends upon the time that the deviation lasts.

An instrument with throttling control and automatic reset will make two corrections, one for the initial deviation and another which will continuously change as long as the deviation lasts. This type of instrument will handle changes of load and still maintain the proper control point.

Using our plant as an example we could not only change the inlet temperature but also change the flow rate over a rather wide range and still maintain an outlet temperature of 180° F.

The past few years have witnessed the development of a third control function, the second derivative type. This type of control gives a change in the con-

trol air for the velocity with which the pen is deviating from the control point. If the temperature starts to drop rather fast it will throw the valve open to check its fall, and as soon as the temperature stops dropping, it will close the valve back to the position that it would have had with only throttling control.

The application of the second derivative type of control has been limited mainly to the control of temperatures. Its use seems to be particularly advantageous where the controller has a large capacity to overcome in steps 3 and 7 of our control cycle.

Figure 7 shows our process controller on the water heater. The instrument will change the air to the control valve in response to changes in load. These changes are the result of the three primary control functions, i.e., throttling, reset, and second derivative type. The control valve has been designed to give equal percentage increases of flow with equal increasement of lift.

There remains then a gap in our control system. We have a precision instrument to modulate the air to the control valve, and a control valve that gives precision response to increase in lift, but nothing to make sure that this lift corresponds to the change of air pressure. If the valve had a tight packing gland, the resulting loss of response would be enough to upset a control system that might otherwise give good control.

The instrument companies have developed a valve positioner that will place the valve plug at precisely the position called for by the air pressure from the instrument. The use of the valve positioner will eliminate the mechanical friction losses in the valve and help to smooth out the control system. It is practically a necessity on installation that requires a wide throttling range.

The instrumentation as shown in Figure 7 should handle any changes in load and bring the pen back to the control point. It should be remembered that the pen will have to deviate from the desired control point before the instrument can compensate for the change in load. It is good control practice, therefore, to eliminate as many upsets as possible before they reach the instrument.

In our water-heating example we have changes in flow rate and inlet temperatures which cannot be helped, but we can compensate for a change in steam pressure. This can be done in several ways. We can install a pressure controller ahead of the steam valve, or a differential controller across the control valve. The method which is gaining favor in the industry is the use of a flow controller which has its control point set by the temperature controller. With such a control system the flow controller will hold whatever flow is desired by the temperature controller and will take care of any upsets that occur in the steam system before they reach the temperature controller.

A control system using a pneumatic-set flow controller is shown in Figure 10.

The foregoing has been a rather simple illustration which has shown the development of the modern control system. The modern controller has no single complicated fact connected with it, but rather it is merely a coordinated collection of simple fundamental mechanism to give the desired end result. We started with the simple on-off controller and finally arrived at the pneumatic set unit.

The use of the pneumatic set unit is becoming more and more popular with the industry. It is not restricted as temperature resetting flow, but to several combinations such as level resetting flow, pressure resetting level, etc.

In our example we were heating a liquid to a temperature well below its boiling point. The flow of steam per degree of heat applied to the liquid is practically the same amount through the range of operation. For this reason we choose a pneumatic-set flow controller. If this application had been on the reboiler of a fractionator column handling a wide-boiling-range material such as naphtha or gasoline we would have selected a pneumatic-set flow controller also.

If on the other hand the application was on a reboiler of a fractionator handling a practically pure hydrocarbon at the base, it would be much better to use a pneumatic-set pressure controller. The amount of heat required to evaporate the liquid is very much more than the amount of heat required to superheat the vapors. With the column in operation and receiving a sudden drop of load, the temperature controller has been calling for a certain flow of steam to maintain the proper conditions at the base of the tower. With the load change, the former amount of steam will be sufficient to boil away everything at the base of the column and even superheat the vapors way above the required temperature. The flow controller will continue to pack steam into the reboiler and consequently raise the steam pressure in the reboiler as the heat is not being used as fast as it was when there was liquid present over the tubes.

Because the heat is not being withdrawn from the reboiler the flashed bottoms eventually will be condensed by the reflux in the tower and fall back down to the reboiler where it hits the tubes that now have more steam pressure in them than they did when the liquid was flashed off the first time. This condition is especially bad in a tower that uses a trap tray and exchanger type reboiler, rather than the kettle type with its larger capacity.

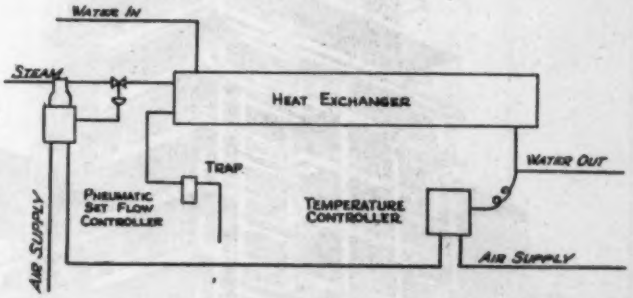


FIGURE 10
Control system using pneumatic-set flow controller

Use of a pneumatic-set pressure controller would prevent the steam pressure build-up in the reboiler and the consequent aggravation of the surging condition.

The foregoing has been a rather simple example of a control application but it serves to show some of the problems confronting the instrument engineer. He not only has to have exact knowledge of the flow quantities involved, but also a good general knowledge of the operation of the unit.

The instrument engineer takes the inanimate towers, condensers, reboilers, pumps, lines, etc., from the design engineer and animates them by means of his various controls and valves. He supplies the brains and nerves of the plant.

Measurement of Solids In TCC Process

A. E. KELLEY, Union Oil Company of California

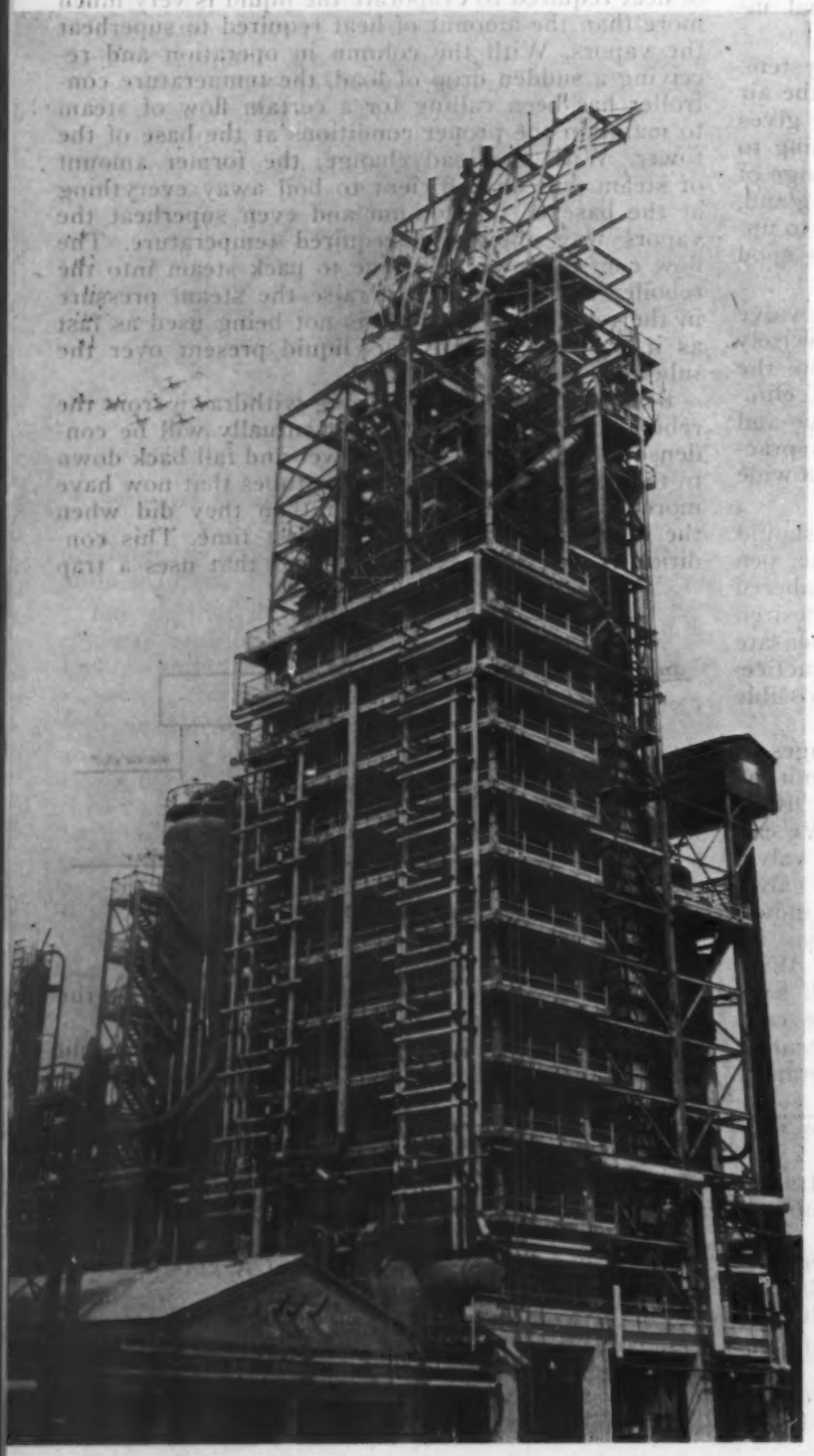


FIGURE 1 is a flow sheet of the catalytic section of the Thermofor Catalytic Cracking Process. Regenerated catalyst from the kiln is carried by a bucket elevator to the reactor hopper located about 70 feet above the reactors. Gravity causes the catalyst to flow down and through the catalyst pressure legs, the upper seal and distributing pipes, the reactor proper where the oil contacts the catalyst, the bottom seal and distributing plates, and into another bucket elevator which carries it to the top of the kiln. The coked catalyst then flows by gravity down through the kiln where the coke is burned off with air, and thus the cycle is completed. Fresh catalyst is added, by means of the fresh clay elevator, to a preheater. The hot catalyst then flows by gravity into the kiln feed elevator. To prevent the build-up of catalyst fines in the system, a slip stream of regenerated catalyst is passed down through the elutriator countercurrent to a flow of flue gases. The flow of flue gases is such that it carries fines with it, but allows the catalyst pellets to drop into the top of the kiln over which the elutriator is mounted. Catalyst fines carried out with the flue gases are collected by means of cyclone separators and stored in a fines tank prior to removal from the unit. The hot-clay storage tank is used to hold catalyst from the kiln or reactor when it is necessary to work in them. Operating upsets causing high levels in the reactor hopper may also cause a spillage of catalyst into the hot-clay tank. The catalyst can then be added back into the system by means of the fresh-clay elevator.

Instrumentation

Flow Indicators, F-1

Accurate catalyst circulation rate is desirable from both a process and operating standpoint and is obtained in this unique system in a very simple and efficient manner.

The energy required to run the motors which drive the clay elevators at their constant chain speed of about 100 feet per minute is measured by means of a kilowatt meter located in the control house. As the load or catalyst weight in the buckets is increased, the motor power requirements increase. Thus to obtain the catalyst circulation rate all that is needed is a correlation between power required to drive the motor and the quantity

THE Thermofor Catalytic Cracking unit is divided into a catalyst section and an oil section, which are integrated in the reactors. The oil section, which handles the hydrocarbons before and after the reactors, contains equipment common to the oil industry, but the catalyst section is novel. In the catalyst section the process solves the problem of coke removal by moving the pelleted or bead catalyst continuously through the reaction and regeneration steps. The purpose here is to discuss the general methods and equipment used in the measuring and establishing of catalyst flow rates, catalyst levels, and reactor seals.

This paper was read before the July, 1945, meeting of Southern California Meter Association.

of catalyst being carried. This calibration is obtained experimentally for each elevator. A typical curve is shown in Figure 2. The method used in obtaining the curve is as follows.

The clay rate is set to the elevator to give a constant power requirement, as indicated by the kilowatt meter, and the circulation is stopped. The content of three of the buckets is then removed and weighed. Assuming all the buckets containing catalyst to be equally loaded, the circulation rate in tons per hour can be easily calculated by multiplying the catalyst weight per bucket by the elevator chain speed in buckets per hour and dividing by 2000, to convert pounds to tons. About three points at different loads will establish the curve. If desired the kilowatt meters in the control house can be marked directly in tons per hour circulation.

Flow Control Valves, FC

The catalyst flow rates are varied by means of piston operated butterfly valves in the positions shown in Figure 1. These valves are normally operated remotely from the control house.

Air pressure is transmitted manually to a valve controller with positioner operating an air piston and is both recorded and indicated in the control house. The pistons movements are translated into movements of the butterfly control valve through a suitable linkage and worm-gear arrangement. Also operated by the piston arm movements are two limit switches. These indicate, through actuation of green

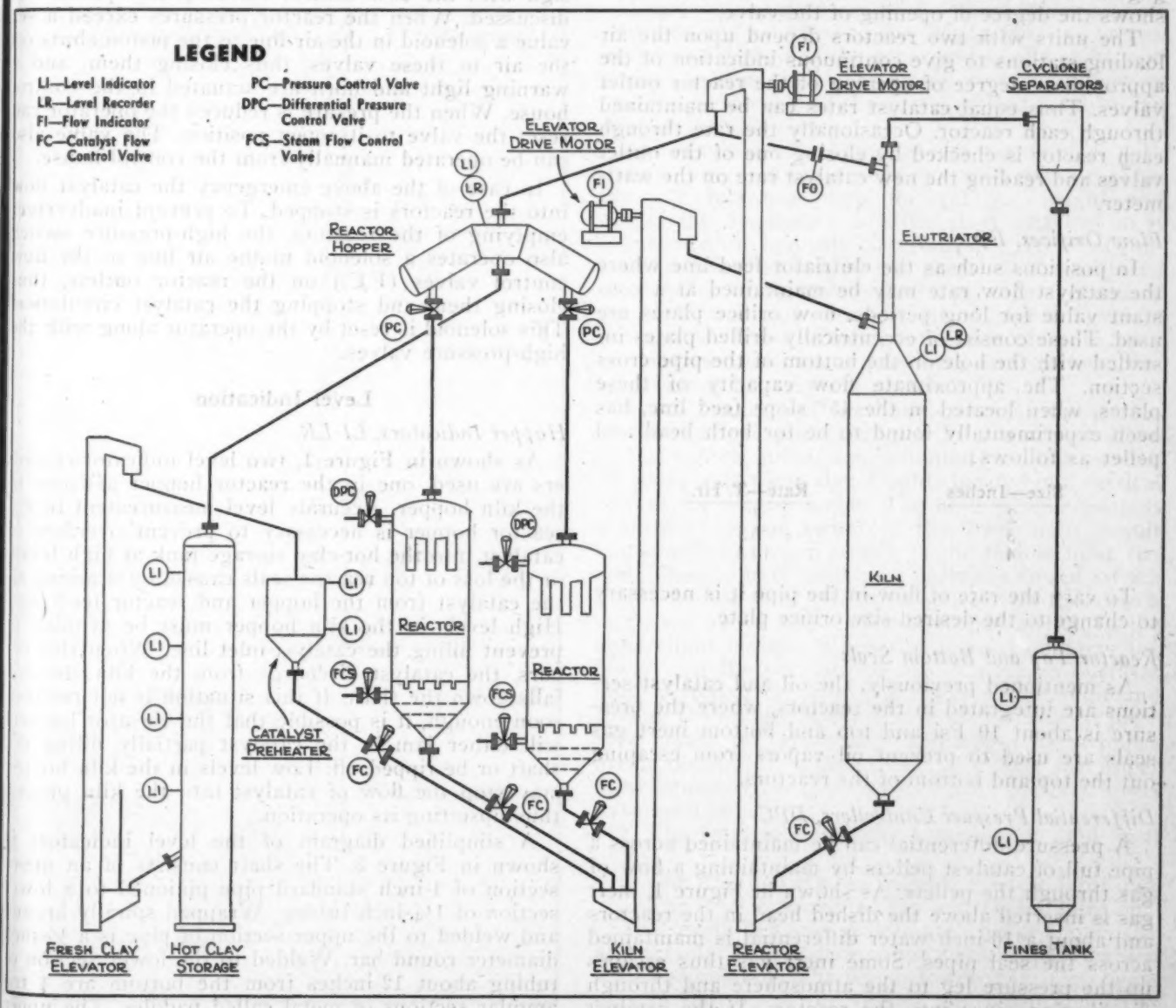


FIGURE 1
General catalyst flow sheet

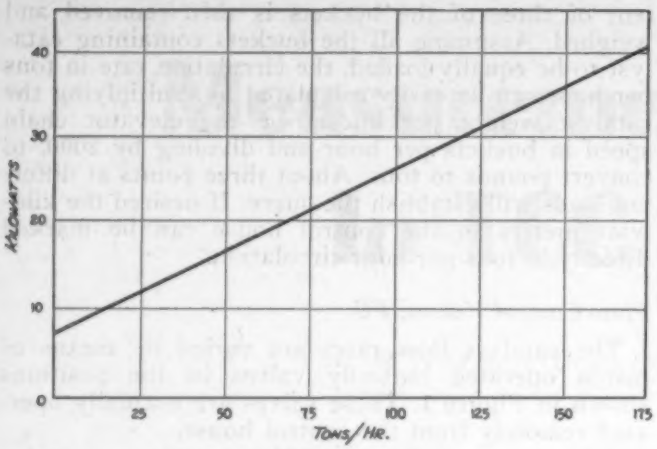


FIGURE 2
Elevator calibration curve

and red lights whether the valve is in a closed or partially open position.

If desired, the valves can be operated by hand. To do this, transmitted air to the controller is shut off at the valve and the hand-driven worm gear is engaged. A pointer on the hand-driven worm gear shows the degree of opening of the valve.

The units with two reactors depend upon the air loading stations to give continuous indication of the approximate degree of opening of the reactor outlet valves. Thus equal catalyst rates can be maintained through each reactor. Occasionally the rate through each reactor is checked by closing one of the outlet valves and reading the new catalyst rate on the watt-meter.

Flow Orifices, FO

In positions such as the elutriator feed line where the catalyst flow rate may be maintained at a constant value for long periods, flow orifice plates are used. These consist of eccentrically drilled plates installed with the hole on the bottom of the pipe cross section. The approximate flow capacity of these plates, when located in the 45° slope feed line, has been experimentally found to be for both bead and pellet as follows:

Size—Inches	Rate—T/Hr.
2	2
3	6.5
4	14.3

To vary the rate of flow in the pipe it is necessary to change to the desired size orifice plate.

Reactor Top and Bottom Seals

As mentioned previously, the oil and catalyst sections are integrated in the reactors, where the pressure is about 10 Psi and top and bottom inert gas seals are used to prevent oil vapors from escaping out the top and bottom of the reactors.

Differential Pressure Controllers, DPC

A pressure differential can be maintained across a pipe full of catalyst pellets by maintaining a flow of gas through the pellets. As shown in Figure 1, inert gas is inserted above the dished head in the reactors and about a 10-inch water differential is maintained across the seal pipes. Some inert gas thus escapes up the pressure leg to the atmosphere and through distribution pipes into the reactors. If the catalyst is drained from the presure legs, the differential pressure can no longer be maintained and oil vapor can escape up the leg to the atmosphere. The differential is controlled from the control house and if it falls below a minimum set value, warning light and horn are actuated.

Bottom Seal Flow Controllers, FCS

Again referring to Figure 1, it is seen that steam is introduced in the bottom of the reactors between the top two (2) distributing plates. A sufficient quantity is used to cause a flow of steam both into the reactor proper and out the bottom catalyst line where it is drawn off at about atmospheric presure. The rates of sealing steam is controlled from the house and if it falls below a minimum set value a warning light and horn are actuated.

Pressure Control Valves, PC

The reactor pressure legs are of such length that the head of catalyst is great enough to gravitate the catalyst into the reactors under their normal operating pressures of 10 psig. Surges of pressure could, however, stop this flow and blow the catalyst along with oil vapor back into the hopper. To prevent this from happening, the reactor feed lines are equipped with pressure control valves (P.C.) identical in design with the flow control valves (F.C.) previously discussed. When the reactor pressures exceed a set value a solenoid in the air line to the piston shuts off the air to these valves, thus closing them, and a warning light and horn are actuated in the control house. When the presure is reduced the operator can reset the valve to its open position. The valve also can be operated manually from the control house.

In case of the above emergency the catalyst flow into the reactors is stopped. To prevent inadvertent emptying of the reactors, the high-pressure switch also operates a solenoid in the air line to the flow control valves (F.C.) on the reactor outlets, thus closing them and stopping the catalyst circulation. This solenoid is reset by the operator along with the high-pressure valves.

Level Indication

Hopper Indicators, LI-LR

As shown in Figure 1, two level indicator-recorders are used, one in the reactor hopper and one in the kiln hopper. Accurate level measurement in the reactor hopper is necessary to prevent overflow of catalyst into the hot-clay storage tank at high levels or the loss of top reactor seals caused by draining all the catalyst from the hopper and reactor feed legs. High levels in the kiln hopper must be avoided to prevent filling the catalyst-inlet line. When this occurs, the catalyst discharge from the kiln elevator falls down the shaft. If this situation is not rectified soon enough, it is possible that the elevator buckets will either jam in the catalyst partially filling the shaft or be ripped off. Low levels in the kiln hopper may stop the flow of catalyst into the kiln proper, thus upsetting its operation.

A simplified diagram of the level indicators is shown in Figure 3. The shaft consists of an upper section of 1-inch standard pipe pinioned to a lower section of 1¼-inch tubing. Wrapped spirally around and welded to the upper section of pipe is a ½-inch diameter round bar. Welded to the lower section of tubing about 12-inches from the bottom are 4 triangular sections of metal called paddles. The upper section of pipe rides up and down through a sleeve with a matching spiral and the pipe spiral engages

the sleeve spiral. The sleeve sets on a bearing which prevents its vertical movement, and is rotated at constant speed by means of a motor. The shaft is properly weighted so that gravity causes its movement downward. The purpose of the bottom spear-like point of the shaft is to provide a resistance which will counteract a tendency of the paddles to force the shaft to move in a horizontal plane.

As the paddles came in contact with the catalyst, they tend to slow down the rotation speed of the shaft. The sleeve, which continues to rotate at a constant speed, transmits an upward pressure from its spiral to the section of pipe spiral in contact with it. This forces the shaft and paddles to move upward and out of the catalyst. If the shaft moves too far, gravity causes it to drop again. Finally, a condition is reached when these two forces are equalized and the paddles ride the surface of the catalyst with the shaft moving at the same speed as the sleeve.

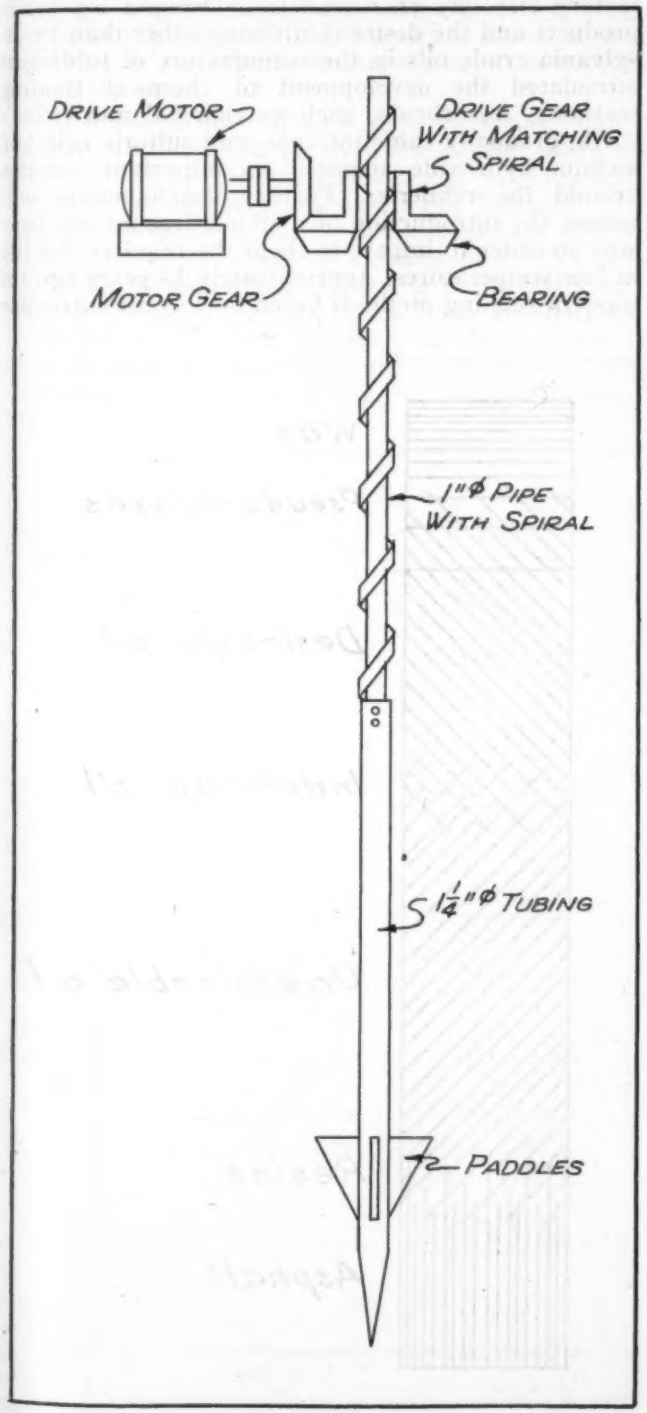


FIGURE 3
Continuous level indicator

Because of their importance, hopper levels are pneumatically transmitted to the control house where they are indicated and recorded. Vertical movements of the shaft acutate the pneumatic transmitter by means of a weighted chain-and-sprocket arrangement. At high levels a mercoid pressure switch, operating on the transmission air, sounds a horn and actuates a red light in the control house.

Manually-operated level indicators, consisting of a piece of pipe with a cone bottom, are used to check the automatic indicators at intervals.

Storage Tank Level Indicators, LI

As shown in Figure 1, level indicators are located on the hot-clay storage tank, on the catalyst preheater, and in the fines tank. These level indicators are actuated by catalyst pressure and their use differs from the type discussed above, as they only indicate that the level is below, at, or above the point at which they are located. The exact level must be obtained manually. This type of indicator is suited to level measurements in these vessels, as continuous accurate measurement is not necessary.

These indicators consist of a diaphragm, a shaft with one end attached to the diaphragm, one or two switches attached to the other end of the shaft, and a suitable housing. The assembly is mounted over an opening in the side of the vessel so that catalyst can contact the diaphragm.

As the catalyst level rises and contact is made with the diaphragm, a pressure is exerted against it. This pressure increases with the catalyst height and causes the diaphragm and the shaft attached to it to move in the opposite direction. The electrical contacts or switches attached to the shaft are adjusted to make or break control for a given movement of the shaft and thus turn on and off signal lights in the control house. Through the use of more than one of these units an approximate catalyst level can be obtained for very tall vessels.

As an example of their use, the instrumentation of the catalyst preheater will be considered. Two double-switch units are mounted on this vessel. These actuate three signal lights located in a vertical row in the control house. The bottom unit contains a normally closed switch in the lower light circuit and a normally open switch in the middle light circuit. The top unit contains a normally closed switch in the middle light circuit in series with the switch discussed above and a normally open switch in the upper light circuit. When the catalyst contacts the lower unit the pressure on the diaphragm operates both switches, breaking the lower light circuit and closing the middle light circuit. As the catalyst pressure moves the upper unit diaphragm its switches break the middle light circuit and close the upper light circuit. Thus three approximate catalyst levels have been indicated:

1. The level is below the bottom unit (red light on).
2. The level is between the units (white light on).
3. The level is above the top unit (green lignt on).

The levels in these vessels are checked manually at intervals. This is done using a steel tape weighted with a plumb bob. The tape is lowered through openings in the top of the vessels and when contact is made with the catalyst, the distance is read on the tape.

Manufacture of Lubricating Oils

V. A. KALICHEVSKY
Technical Department, Refining Division,
Magnolia Petroleum Company, Beaumont, Texas

LUBRICATING oils represent only three percent by volume of petroleum products sold on the market. This figure appears small on the surface but, because of the size of the petroleum industry, the total volume of these oils manufactured in 1940, the last year for which reliable figures are available, reached a respectable total of 1,544,130,000 gallons. Moreover, the average price of lubricating oils per unit volume output is several times greater than that for average petroleum products, thus very considerably enhancing their relative importance to the refineries.

Value of petroleum as a source of lubricants has been realized since soon after it became available in reasonable quantities. It may be stated without exaggeration that this discovery stimulated the progress in mechanical developments which was very rapid in the second half of the nineteenth century and paved the way to our present civilization. The progress would have been impossible without employing petroleum as the base material in the manufacture of lubricating oils. For this reason the historical era in which we are now living may be referred to as Petroleum Age in due recognition of these achievements.

Adoption of crude oil for lubricating service resulted in the necessity of initiating a great amount of research and development work for solving innumerable problems encountered in this field of human activities. Difficulties in lubricating-oil manufacture arise not only from the structural differences between various types of machinery but also from peculiar uses or handling to which they are exposed. The total volume of lubricating oils sold by the industry is subdivided into several thousands of individual products in addition to a multitude of local formulas developed for meeting some highly specific problems. These complications have a direct bearing on manufacturing problems encountered in the lubricating-oil field with which this article is directly connected.

At the beginning little was known about oil refining, and petroleum lubricants sold on the market consisted mainly of unrefined residual stocks. Pennsylvania oils, which represented at that time the only mineral oil source of commercial importance, were particularly suited for this purpose because of their very low asphalt content and attractive color. Even now some of these oils are marketed directly as they are produced at the stills.

Development of Chemical Treatment

Very soon distillation methods began to improve permitting manufacture of distillate stocks of satisfactory viscosity characteristics. Demand for better products and the desire of utilizing other than Pennsylvania crude oils in the manufacture of lubricants stimulated the development of chemical treating methods. Adsorbents, such as charcoal and fuller's earth, gradually came into use, and sulfuric acid and sodium hydroxide acquired an important position around the refineries. Further developments witnessed the introduction of methods freeing oils from wax in order to impart to them the required fluidity at low temperatures. Approximately 15 years ago the modern refining methods based on solvent extraction

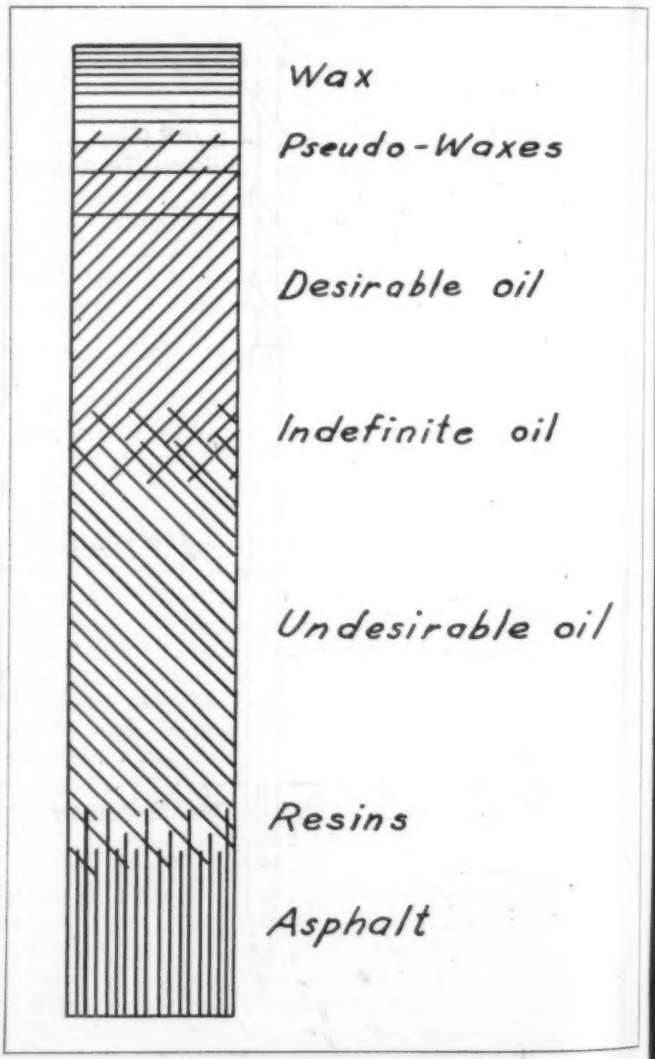


FIGURE 1
Composition of crude lubricating oil fractions

started to revolutionize the industry, and at about the same time the quality of oils was found to be further improved by the introduction of additives.

However, development of new refining methods did not result in complete extinction of the former practices which are still retained to a more or less limited extent in the manufacture of certain products for economic or quality reasons. Thus the new developments complicated rather than simplified refining problems and added to the volume of experimental work which must be handled by the research organizations in their hunt for improved products. Recent discoveries of a large variety of additive agents multiplied such possibilities almost to infinity.

Crude lubricating-oil fractions consist of asphalt, wax, undesirable, and desirable oil constituents although some of them, such as the first two, may be occasionally absent. The refiner is faced with the problem of separating the desirable oil constituents from the rest.

The above classification appears simple but the actual dividing line between these four major constituents is by no means sharp and varies with the type of product manufactured. For instance, in removing asphalt a series of intermediate fractions gradually approaching oil in their properties is isolated by progressively increasing the severity of refining. These intermediate fractions are frequently referred to as resins. Similarly no demarcation line can be drawn between oil and wax because of the existence of indefinite groups of compounds known as pseudo-waxes. Separation of desirable from undesirable oil constituents is subject to the same limitations. Figure 1 demonstrates these complications by a schematic representation of crude-oil composition. For all practical purposes the oil should be regarded, therefore, as a material continuously changing in its properties by subsequent removals of narrow bands of its constituents. Abrupt changes are apparent only when large quantities of these constituents are eliminated in one operation.

TABLE 1
Removal of Oil Constituents by Commercial Refining Processes

Refining Process	CONSTITUENTS REMOVED		
	Asphalt	Undesirable Oil	Wax
Distillation	Yes	No	No
Sulfuric acid	Yes	Yes	No
Aluminum chloride	Yes	Yes	No
Solvent desasphalting	Yes	No	No
Single solvent refining	Some	Yes	No
Double solvent refining	Yes	Yes	No
Dewaxing	No	No	Yes
Adsorbents	Yes	No	No

Many refining agents have been suggested for processing lubricating oils, but most of them are either of limited application or have no practical significance. Table 1 classifies the best known commercial treating methods with respect to their general effect on the various oil constituents. Because of the somewhat indefinite characteristics of oil components, removal of minor quantities of substances other than indicated under the individual processes

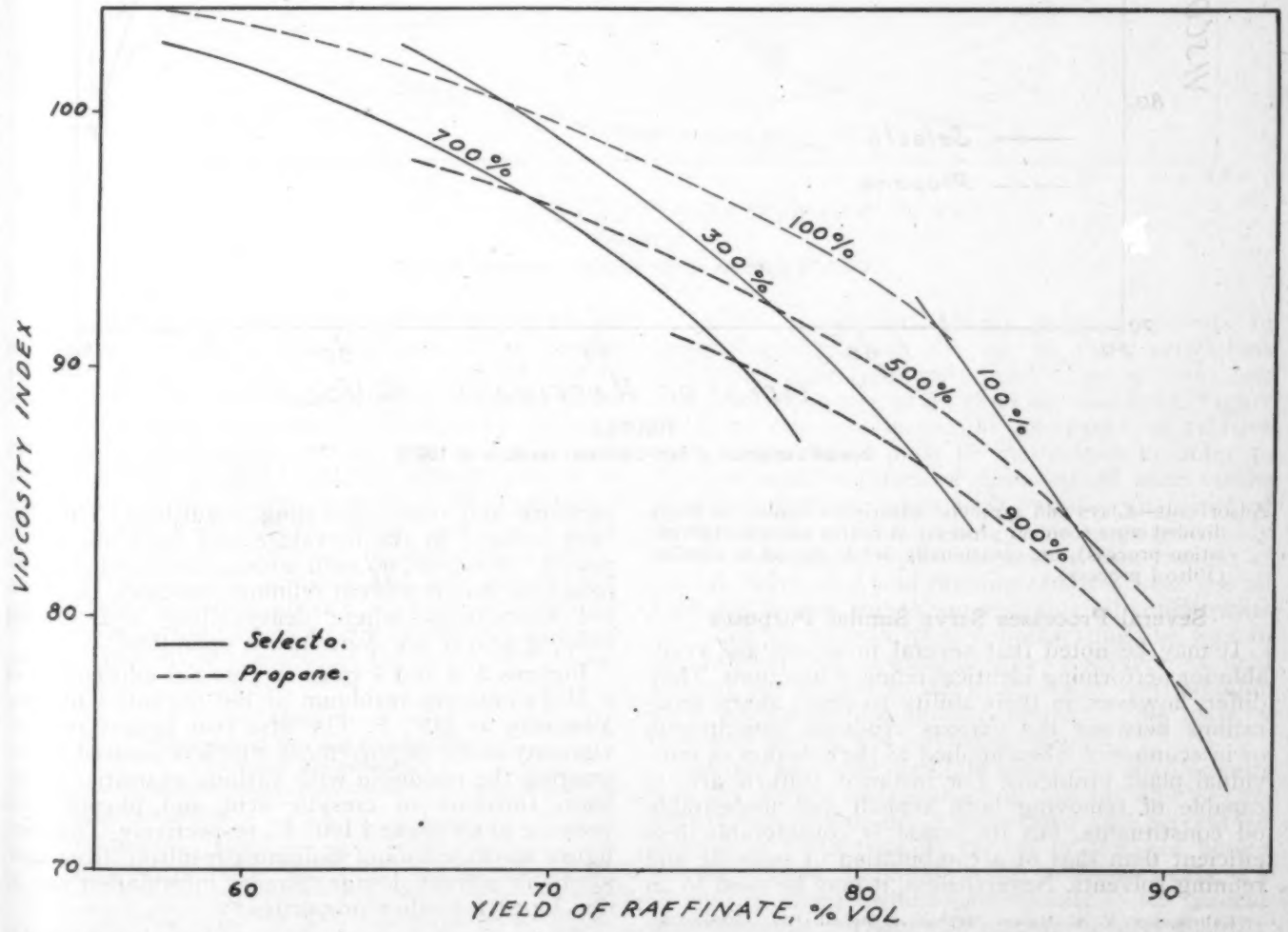


FIGURE 2
Duo-sol extraction of Mid-Continent residuum at 80°F.

is possible, however, by most of these methods if the degree of refining is carried to an extreme.

In the above table most of the processes are shown by groups because of similarity in their refining action. Commercially important processes belonging to each individual group are:

Solvent deasphalting—Propane deasphalting

Single-solvent refining — Chlorex, furfural, nitrobenzene and phenol processes

Double-solvent refining—Duo-Sol process employing propane and cresylic acid.

Dewaxing—Cold settling (practically obsolete), cold pressing, naphtha centrifuging, benzol-ketone, Bari-Sol (chlorinated solvents) and propane dewaxing processes.

Adsorbents—Clays and synthetic adsorbents applied in finely divided state (contact process) in coarse particles (percolation process), or, occasionally, while the oil is distilled (Filtrol process).

Several Processes Serve Similar Purposes

It may be noted that several processes are available for performing identical refinery functions. They differ, however, in their ability to effect sharp separations between the various crude-oil constituents or in economics when applied to the solution of individual plant problems. For instance, sulfuric acid is capable of removing both asphalt and undesirable oil constituents, but its action is considerably less efficient than that of a combination of propane and refining solvents. Nevertheless, it may be used to an advantage in preparation of special oils or of oils requiring only a mild degree of refining. Some complications also arise in the choice of dewaxing processes as not all of them are suitable for separating every type of wax which might be associated with the oil. Thus cold pressing is applicable only to distillate stocks containing paraffin wax, naphtha centrifuging to residual stocks carrying microcrystalline wax, while benzol-ketone and other modern processes are much more universal in their action.

Each individual process has a considerable degree of flexibility within itself because of possible variations in quantities of reagents employed or in temperature and other operating conditions. This has been covered in the literature and need not be repeated.[1] However, no such information has been published on double-solvent refining processes, i.e., Duo-Sol extractions, where deasphalting and solvent refining proper are done in one operation.

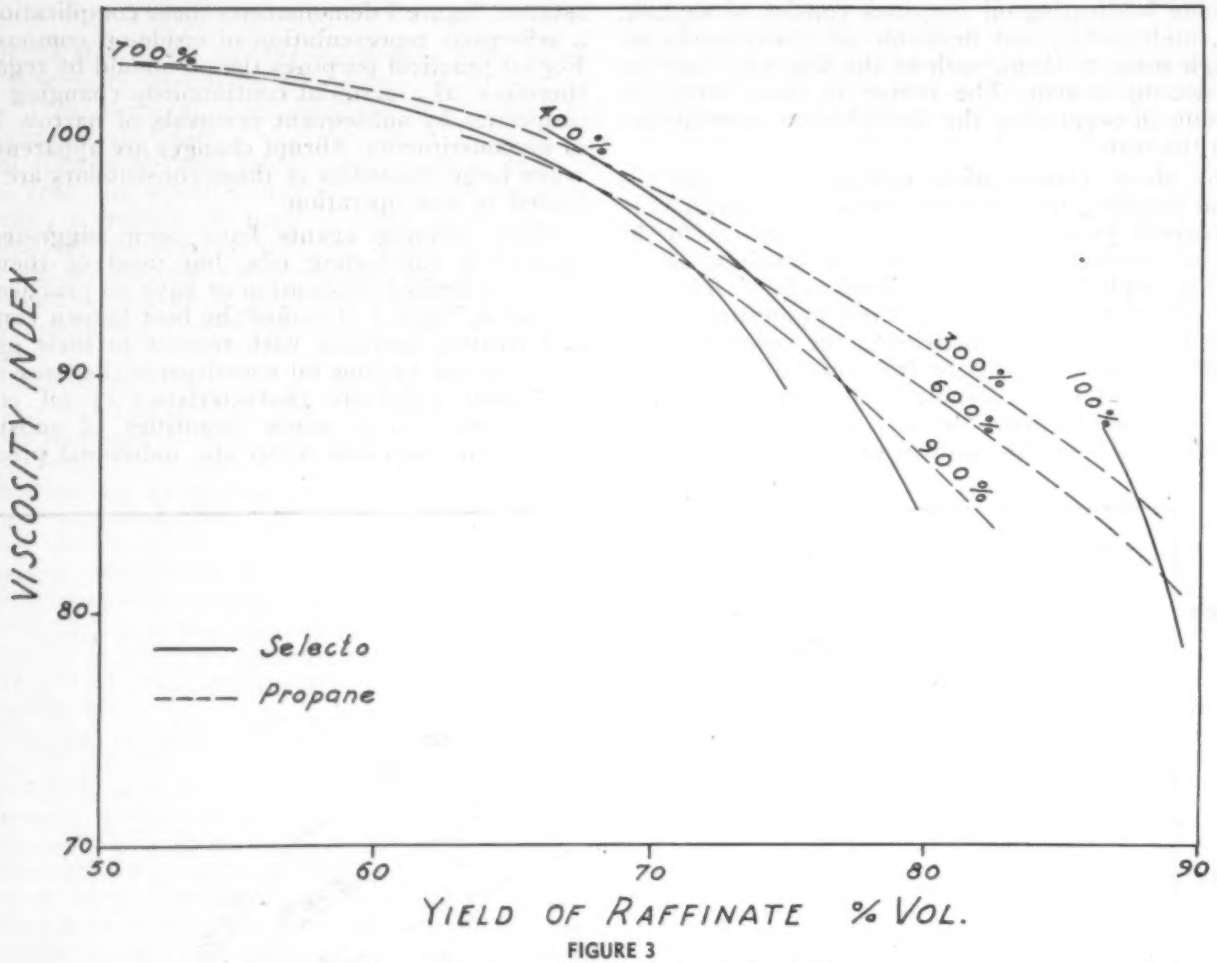


FIGURE 3

Duo-sol extraction of Mid-Continent residuum at 100°F.

Figures 2, 3 and 4 refer to Duo-Sol extractions of a Mid-Continent residuum of 150 Saybolt Universal Viscosity at 210° F. The first two figures refer to viscosity-index improvement which is secured by extracting the residuum with various quantities of Selecto (mixture of cresylic acid and phenol) and propane at 80° F. and 100° F., respectively. The third figure shows colors of raffinates resulting from variations in solvent dosage. Similar information can be developed for other properties.

These figures show that a 100-viscosity-index product may be obtained by applying, for instance,

[1] Kalichevsky, V. A., Modern Methods of Refining Lubricating Oils, ACS Monograph No. 76 (1938). Reinhold Publishing Corp., Kalichevsky, V. A. and Stagner, B. A., Chemical Refining of Petroleum, 2nd Edition, ACS Monograph No. 63 (1942). Reinhold Publishing Corp.

300 percent wt. propane and 500 percent wt. selecto at 80° F. By maintaining the same solvent ratio but raising the treating temperature to 100° F. the viscosity index of the product is lowered to 98. However, the same 100 viscosity index may be obtained if the severity of treat at 100° F. is increased to 300 percent wt. propane and 600 percent wt. selecto or if the quantities of solvents are lowered to 200 percent wt. propane and 350 percent wt. selecto.

Although some of the products are identical with respect to viscosity-index investigation of other properties shows that they are quite different in many respects. This may be visualized from the data shown in Table 2.

TABLE 3

Variations in Viscosity Indices and Viscosity-Gravity Constant of Duo-Sol Refined Oils

TREATING CONDITIONS				PROPERTIES				
Temp. °F.	Propane Percent Weight	Selecto Percent Weight	Yield Percent Vol.	Viscosity Index	Color Lov.	V.-G. Constant	SUV 210° F.	Carbon Residue
100	900	700	71.5	95	25	0.793	80	0.08
100	200	220	74.0	95	210	0.804	91	0.09
100	200	600	54.0	102	130	0.793	81	0.34
100	900	340	78.0	88	40	0.804	87	0.25

traction temperature. Viscosity indices of the two latter oils are, however, 102 and 88, respectively. This is demonstrated in Table 3.

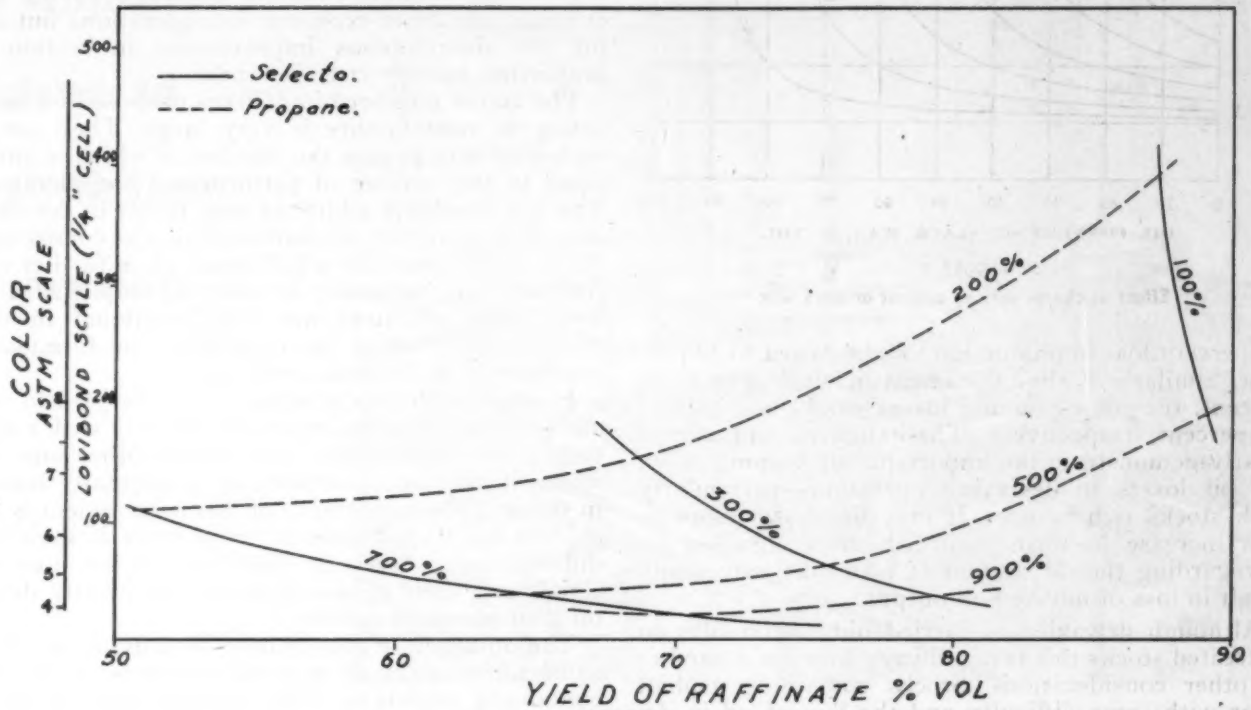


FIGURE 4

Duo-sol extraction of Mid-Continent residuum at 100°F.

Viscosity-gravity constant is often employed for estimating viscosity index of raffinates. Plots similar to those shown in Figures 2, 3 and 4 reveal that in Duo-Sol refining of a Mid-Continent residuum a 95-viscosity-index product may be obtained by applying 900 percent wt. propane and 700 percent wt. selecto or 200 percent propane and 220 percent selecto at 100° F. Viscosity-gravity constants of these raffinates are 0.793 and 0.804. On the other hand a viscosity-gravity constant of 0.793 may be obtained by applying 200 percent wt. propane and 600 percent wt. selecto and a viscosity-gravity constant of 0.804 may be likewise secured by using 900 percent wt. propane and 340 percent wt. selecto at the same 100° F. ex-

TABLE 2

Properties of Duo-Sol Treated Oils (9 Stage Extractions)

TREATING CONDITIONS				PROPERTIES				
Temp. °F.	Propane Percent Weight	Selecto Percent Weight	Yield Percent Vol.	Viscosity Index	Color Lov.	V.-G. Constant	SUV 210° F.	Carbon Residue
80	300	500	66.5	100	260	0.797	83	0.35
100	300	500	66.0	98	85	0.796	81	0.20
100	300	600	63.5	100	80	0.794	80	0.18
100	200	350	66.0	100	140	0.799	85	0.33

Another important refinery process consists in separating wax from the oil. In these operations difficulties arise frequently in effecting more or less complete separation of oil from the wax cake. Figure 5 shows the loss in output expressed as relative charge rate which must be maintained in order to produce equal volumes of dewaxed oil from stocks of different wax content with variable quantities of oil lost to wax. This oil loss becomes progressively more important with the increase in wax content of the oil. Solvent or acid refining removes from the oil asphaltic bodies and the undesirable oil constituents but none of the wax, thus concentrating the wax in the raffinate. If dewaxing follows solvent or acid refining the oil lost to the wax cake is very valuable as it represents the finished product. This may be demonstrated by the following example.

Assume a neutral distillate consisting of 15 percent wax, 35 percent undesirable constituents and 50 percent of recoverable oil. Assume also a 25 percent oil content of slack wax. If the oil is dewaxed before solvent refining, the total oil lost to the wax cake is 5 percent of charge which corresponds to 5.9 percent of its valuable portion with respect to total quantity of finished product. If the oil is dewaxed after removing the 35 percent undesirable constituents, this

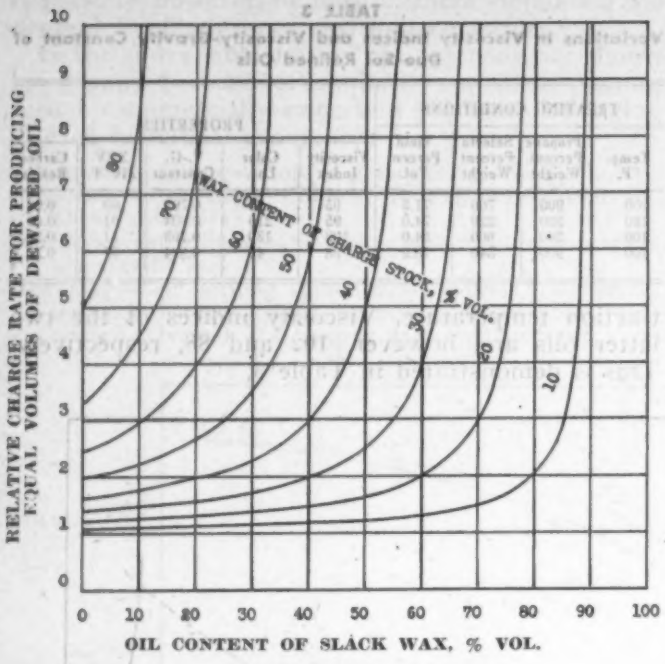

RELATIVE CHARGE RATE FOR PRODUCING EQUAL VOLUMES OF DEWAXED OIL
WAX CONTENT OF CHARGE STOCK, % VOL.
OIL CONTENT OF SLACK WAX, % VOL.

FIGURE 5
Effect of charge rate on content of slack wax

5.9 percent loss in production will be raised to 10 percent. Similarly if the oil content of slack wax is 50 percent, the corresponding losses would be 17.6 and 30 percent, respectively. These figures and curves clearly demonstrate the importance of keeping down the oil losses in dewaxing operations particularly with stocks rich in wax. It may be shown likewise that increase in throughput which is obtained by disregarding the oil content of wax cake may easily result in loss of finished-oil output.

Although dewaxing is carried out, preferably, on untreated stocks this is not always done for a number of other considerations. Stocks containing asphalt filter with some difficulty and the loss of oil in dewaxing may be disproportionate to finished-product recovery. The rate of filtering may also be unduly low. Furthermore, refineries interested in selling waxes, particularly those associated with the residual stocks, frequently are forced to dewax oils after solvent refining because of the difficulty of separating impurities from the wax cake.

The above discussion brings out the importance of a careful balance of the sequence of refinery operations which involves not only the dewaxing but also the rest of the refining processes. For instance, sharper separation is obtained if deasphalting precedes or accompanies and not follows solvent refining, although a superficial analysis may lead to the erroneous conclusion that same results are obtained in either case.

Selection of Crude Oils

Selection of crude oils is a very important refinery problem. Specifications and service requirements vary with the type of product manufactured demanding corresponding changes in the definition of desirable and undesirable constituents. Pennsylvania and Coastal crude oils are not interchangeable because of profound differences in their general characteristics, but both of them find a proper place in refinery operations.

Appearance of additives resulted in the necessity of a thorough revision of manufacturing practices. The use of additives may serve either one of the two purposes: manufacture of improved products or securing production economy without affecting the product quality. The latter purpose may be best demonstrated with reference to dewaxing operations. A zero-pour-point oil can be made by removing all the wax interfering with flow characteristics above this temperature. This is rather expensive because of the necessity of applying low dewaxing temperatures. However, the same zero-pour-point oil may be obtained, for example, by partially dewaxing the stock and then adding a small quantity of a pour-point depressant, like Santopour or similar materials. The second method is often preferable to the first one not only from economic considerations but also for the simultaneous improvement in certain oil properties, namely viscosity index.

The actual number of additives proposed for lubricating-oil manufacture is very large. They can be separated into groups the number of which is almost equal to the number of performance considerations. The use of certain additives may result in deterioration of some of the oil characteristics as compared to those of the base oils which resulted in further multiplication in the variety of additives employed. Likewise many additives are multifunctional in their effects, which must be considered in formulating composition of finished products.

In using additives attention must be paid to their compatibility. This is important not only with respect to the oil manufactured but also to other oils with which it may be voluntarily or accidentally blended in service. The importance of this requirement is self-evident but its achievement in practice is sometimes difficult because certain additives are not inert materials and their beneficial effects frequently depend on their chemical activity.

The optimum degree of base oil refining is not the same for straight mineral oil products or products containing additives. This requires careful studies as otherwise the ultimate product may be of inferior quality. This shows that introduction of new refining methods resulted in a considerable complication of processing technique by increasing the variety of the possible modifications and combinations of the old and new treating procedures.

The primary object of lubricating-oil refining is production of high-quality materials. However, this quality is often evaluated on the basis of various laboratory and engine acceptance tests which are not necessarily well correlated with field performance. Moreover, a number of such requirements was developed on the basis of abstract pseudo-scientific speculations divorced from realities with which they are not necessarily in agreement.

The present problems of practical importance connected with the manufacture of lubricants are primarily those involving better understanding of the recently developed refining methods rather than the search for new processes. New discoveries do not necessarily lead towards development of improved products unless they are thoroughly tested and studied in practice. This type of information is now definitely lacking, and future may bring some unexpected revelations with respect to the proper utilization of the already existing knowledge to our everyday problems.

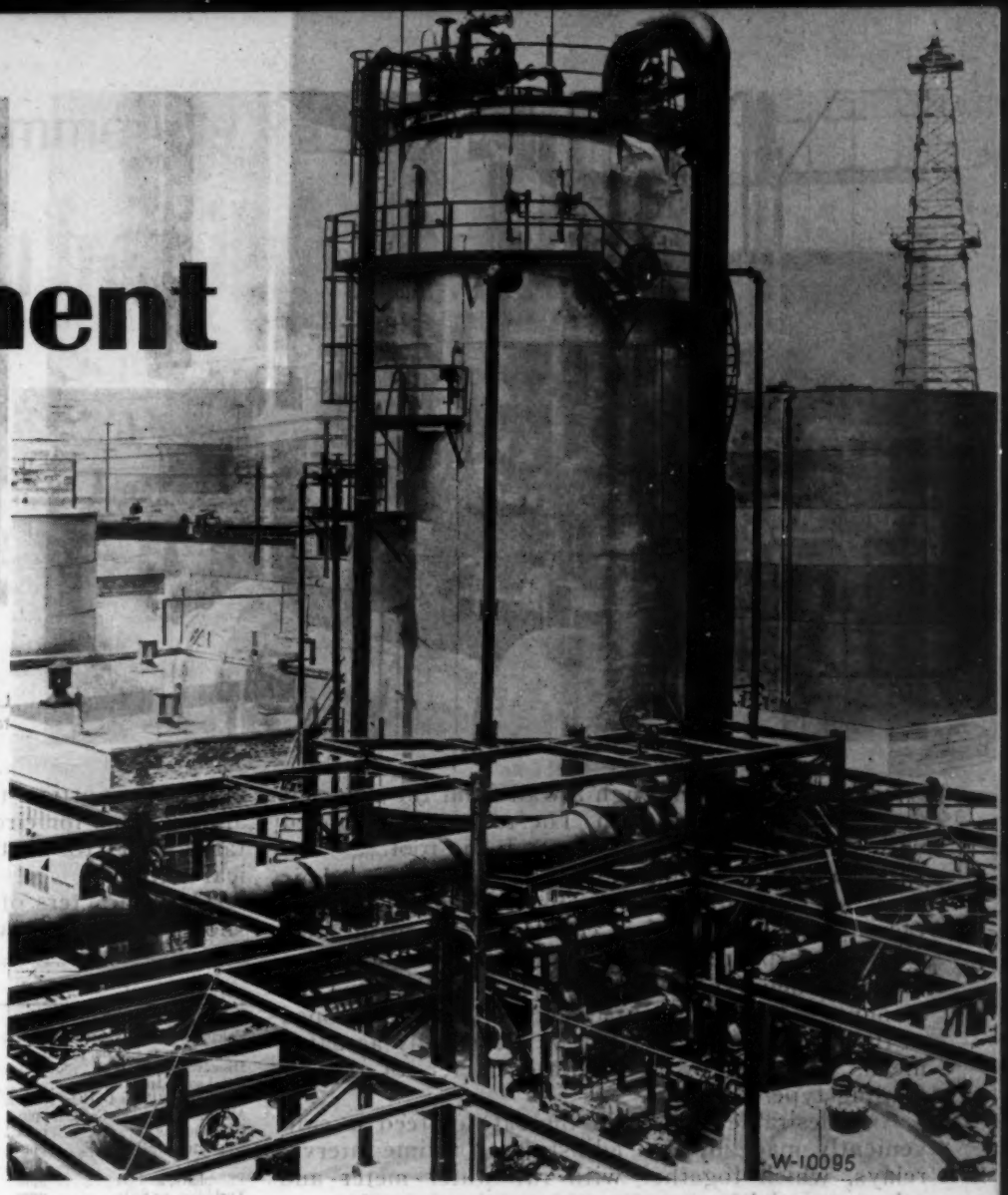
ACKNOWLEDGEMENT

The writer expresses his appreciation to Messrs. J. W. Newton, W. W. Leach, and P. L. Smith for permission to publish this paper.

Water Treatment

An Important Feature in High-Octane Processing

M. P. ROBINSON,
Worthington Pump and Machinery Corporation



General view of softener and chemical building

THE large expansion of The Texas Company's high-octane gasoline production facilities at its Los Angeles refinery necessitated a great increase in steam capacity, with corresponding enlargement and purification of the boiler-water supply.

A new well was drilled and a water-treating system involving several noteworthy design features installed.

In a minimum of ground space, the water treating plant was designed to meet the following requirements:

1. Softening to zero hardness to prevent boiler scale.
2. Proper reduction of silica for scale prevention.
3. Reduction of the high carbonate alkalinity in the raw water to prevent the necessity for excessive boiler blowdown, and the inhibition of steel embrittlement.
4. Removal of all suspended matter.
5. Heating the raw make-up water to a satisfactory temperature for efficient chemical treatment.
6. Deaeration of the treated water for the prevention of oxygen corrosion.
7. Reheating and deaeration of returned condensate for prevention of oxygen corrosion.
8. Removal of oil from the steam used for heating and deaeration.
9. The maintenance of a phosphate excess in the finished water, which when mixed with the deaerated condensate, would maintain the accepted safe phosphate concentration in the boilers as additional insurance against scale formation.
10. Cleansing the filters without loss of water, without contamination by non-deaerated wash water, and without disturbing the quiescent settling conditions accompanying the treating process.

The treating plant has a rated output capacity of 700,000 pounds per hour of make-up water, and 200,000 pounds of condensate.

All features of the plant except the chemical feeders and the filters are incorporated within the main treating tank, which is 24 feet in dimater and 75 feet high, and contains six compartments for accommodating the several treating and deaerating functions.

The operating steam pressure is 10 pounds psi, and the tank is code constructed with especial earthquake factors, on the basis of a working pressure of 20 pounds psi.

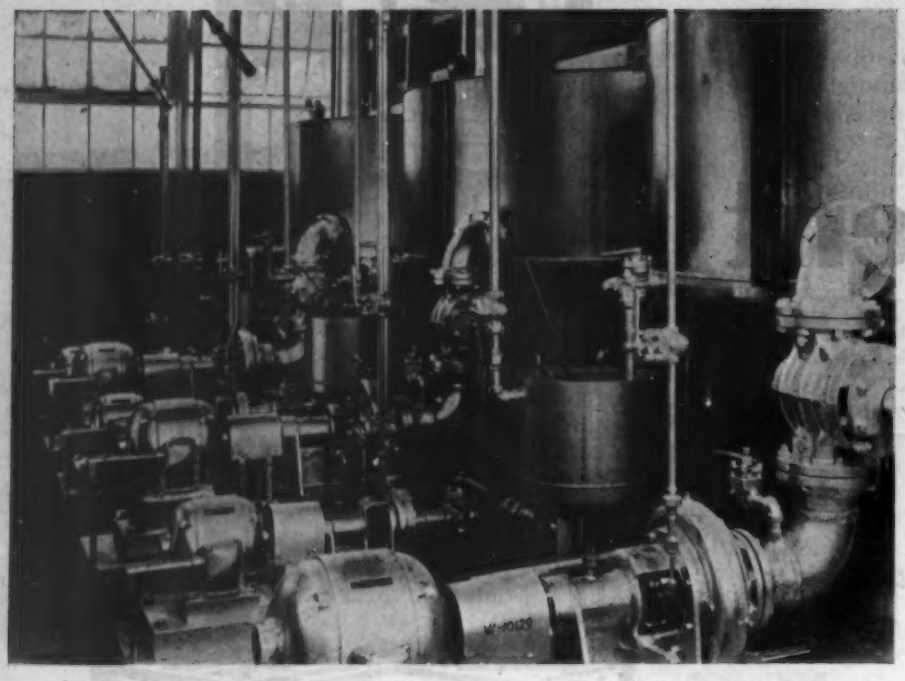
An unusual structural feature for this type of installation is that a spiral stairway provides the approach to various necessary access points about the tank.

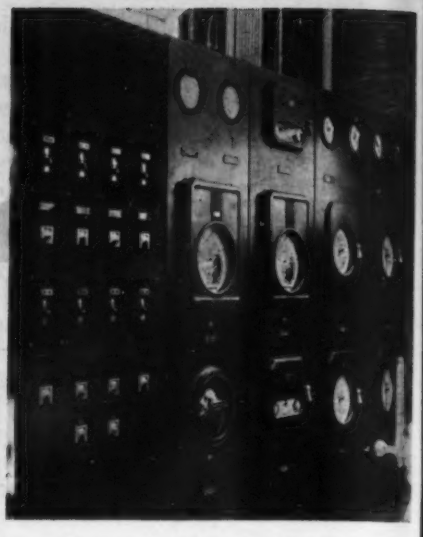
Chemicals used in the process are dolomitic lime, gypsum, ferrous sulphate and phosphoric acid.

The lime and gypsum are received in bags in powdered form, and the acid in carboys.

Before pump delivery to the treating tank, the dry chemicals are changed to a liquid form and the phosphoric acid is suitably diluted.

Three hydraulically agitated mixing tanks are provided for the conversion of the dry chemicals to a wet state of uniform consistency. These tanks are charged through steel chutes attached to their cov-





Instrument and control board

Left—Chemical mixing tanks, hydraulic agitating systems and chemical delivery pumps.

ers, and extending through a wall from the adjacent dry chemical storage room. The tanks are equipped with vent pipes extending through the roof.

During the charging operation, a compressed-air jet is operated in the vent pipe to induce a partial vacuum, so that dust-free conditions are maintained in the atmosphere surrounding the chutes and tanks.

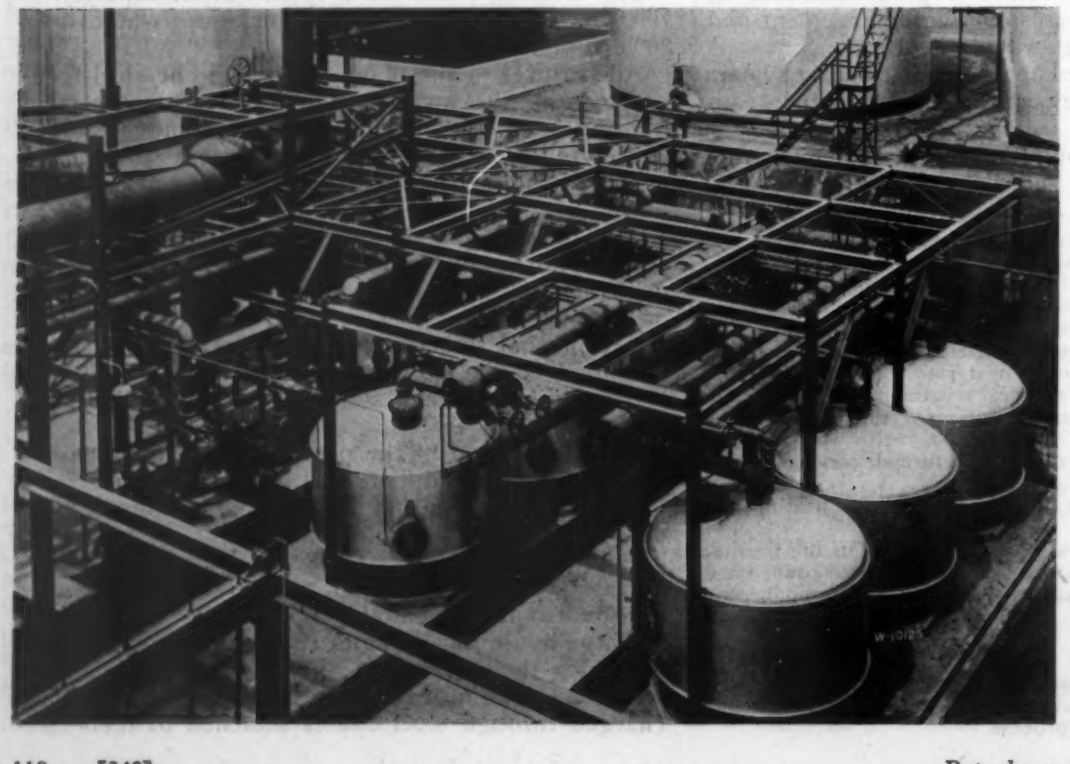
Before delivery to the point of application, the amounts of chemicals are all accurately proportioned to the volume of raw water, by electrically actuated means governed by a raw-water meter, of the recording type.

Any desirable change in the rate of feed is conveniently made by dial adjustment of time-interval relays, which together with raw-water meter and other essential intruments, are panel mounted.

Removal of precipitated impurities is automatic and in proportion to their formation, and facilities are provided for circulating a portion of the precipitated slurry for reutilization of any remaining chemical activity.

The characters of the raw and treated waters are shown by the following analysis:

	Raw	Treated	Method
Total hardness, as $CaCO_3$, ppm	48	0.0	Gravimetric
Calcium as $CaCO_3$, ppm	39.55	0.0	Gravimetric
Magnesium as $CaCO_3$, ppm	5.2	0.0	Gravimetric
Dissolved solids, ppm	281.0	187.0	Gravimetric
Total solids, ppm	282.0	188.0	Gravimetric
Alkalinity, "P" as $CaCO_3$	0.0	30.0	Titration
Alkalinity, "M" as $CaCO_3$, ppm	166.0	64.0	Titration
Chlorides, as Cl ppm	57.0	43.5	Titration
Sulphate, as SO_4 ppm	1.5	33	Photometric
Silica, as SiO_2 ppm	23.2	4.5	Photometric
Phosphate, as PO_4 ppm	0.0	3.2	Photometric
Turbidity, as SiO_2 ppm	0.8	0.8	
pH	8.1	9.7	



Six pressure filters, 11 feet in diameter, for final clarification.

Commercial Production of
Pure Hydrogen from Hydrocarbons and Steam

R. M. REED, Chief Process Engineer,
Gas Processes Division, The Girdler Corporation, Louisville, Kentucky

SUMMARY

THE reaction of hydrocarbons and steam at 1400 to 1800° F. over a nickel catalyst to produce carbon oxides and hydrogen, followed by the water gas shift reaction at 800°F. over an iron oxide catalyst, has been utilized commercially in this country on a large scale since 1930 to produce hydrogen containing 1.0 to 1.5 percent methane and 1.5 to 2 percent carbon monoxide.

Calculations with available equilibrium data indicate that above 1500°F. methane and steam can produce hydrogen containing less than 0.1 percent methane without the use of excessive quantities of steam.

A commercial plant has recently been placed in operation which produced hydrogen of the following analysis from propane and steam.

Component	Percent
Carbon dioxide	0.001
Oxygen	0.005
Carbon monoxide	0.001
Methane	0.018
Nitrogen	0.007
Hydrogen	99.968
Total	100.000

To produce this hydrogen, propane is desulphurized and reacted with steam in two stages, after which the crude hydrogen is cooled and CO_2 removed by scrubbing with monoethanolamine solution. Final purification is effected by two stages of carbon monoxide conversion, each followed by carbon dioxide removal.

Available data for the equilibrium constant of the water gas reaction may be correlated by the relationship—

$$\frac{(CO)\,(H_2O)}{(CO_2)\,(H_2)} = K_p = 49.5_e^{7350/(°F.+400)}$$

This correlation has been checked over the temperature range from 80 to 1800°F.

This paper was presented before the meeting of the South Texas Section, American Institute of Chemical Engineers, Galveston, May 25, 1945, and printed in its Transactions, August 25, 1945, Vol. 41, No. 4, P. 453.

THE reactions between hydrocarbons and water to produce carbon oxides and hydrogen have been known for many years, and have been utilized commercially on a large scale for hydrogen manufacture.

The two principal reactions which occur are as follows:

$$C_nH_{2n+2} + nH_2O = nCO + (2n+1)H_2 \quad (1)$$

$$C_nH_{2n+2} + 2nH_2O = nCO_2 + (3n+1)H_2 \quad (2)$$

Both of these reactions are endothermic and are carried out at elevated temperatures (1400°-1800° F.) in the presence of catalysts. Reaction (2) is considered to be (1) followed by

$$CO + H_2O = CO_2 + H_2 \quad (3)$$

The patent literature on the production of hydrogen from hydrocarbons and steam includes numerous references, covering a period of about 70 years. Du Motay[3] (1880) passed naphtha vapors or coal gas and steam over hot lime to produce hydrogen. Mond and Langer[9] (1888) made hydrogen by passing coal gas and steam at 750° F. to 850° F. over reduced nickel or cobalt supported on pumice. Mittasch and Schneider[8] (1915) disclosed the process which became the basis of later commercial practice. They produced hydrogen by reacting hydrocarbons such as methane with steam at temperatures of 1470° F. to 1800° F. over a nickel catalyst supported on a fireproof carrier such as magnesia. However, they employed a regenerative furnace, maintaining reaction temperatures by alternately burning hydrocarbons in the furnace and then passing hydrocarbons and steam through it. Wietzel, Haller and Hennicke later[16] (1933) patented the use of externally-heated vertical alloy-steel tubes for enclosing a catalyst for continuously producing hydrogen from the interaction of hydrocarbons and steam. Hanks, Freyermuth and Potts[6] (1936) described a multiple-tube furnace containing two rows of vertical alloy-steel (24 percent chromium, 20 percent nickel) tubes about 25 feet long and 6 inches in diameter. The furnace had refractory walls, and was heated with a row of burners at the top between the two rows of tubes. The exit flue gases passed out the bottom of the furnace between the tubes. The tubes extended above and below the refractory, being supported at the upper end and connected at the lower end to two horizontal headers. The hydrocarbons and steam entered the top of the tubes and flowed down through the nickel catalyst contained therein, with the reaction products passing out the two bottom headers. With this furnace, space velocities up to 300 volumes of hydrocarbon gas per hour per volume of catalyst could be obtained with a bottom catalyst temperature of 1750° F., and a furnace-wall temperature of about 1900° F. Substantially complete reaction of the hydrocarbons was obtained, the exit gases containing about 1 percent methane.

Shapleigh[14] (1939) disclosed a furnace design which permitted space velocities of 600 volumes of hydrocarbon per hour per volume of nickel catalyst. He employed vertical nickel-chromium-iron alloy tubes 3 to 8 inches in diameter and about 25 feet long, with the hydrocarbons and steam flowing down through the tubes. These were mounted in a refractory furnace, with multiple horizontal burners located at various levels, while the flue gases passed upward countercurrent to the flow of process materials. The tubes projected above and below the refractory, being supported at the top, and connected at the bottom to horizontal headers. With this furnace, higher heating efficiencies were claimed, and the furnace-wall temperatures were only 50° F. above the tube temperatures. The high temperatures possible and the control of temperature obtainable make practical the

Figure 1. Hydrogen plant

highest cracking efficiency without the use of promoted catalysts. However, high temperatures require a rugged refractory catalyst to avoid sintering of the support and consequent loss in efficiency. Commercial operation with this type of furnace has confirmed its effectiveness, while the hydrogen produced has been characterized by an unusually low methane content.

The large-scale commercial development of the process for manufacturing hydrogen from hydrocarbons and steam was carried out by Standard Oil Company of New Jersey,[7] through Standard Oil Development Company, working jointly with I.G. Farbenindustrie. A large plant was installed at Bayway, New Jersey, in 1930, and a second and larger plant was placed in operation May 23, 1931, at Baton Rouge, Louisiana.[8] The latter plant contained three furnaces of the type described by Hanks, Freyermuth and Potts[6], and could produce 9,000,000 cubic feet of relatively pure hydrogen per day. This was later increased to 13,000,000 cubic feet per day.[15] Natural gas is used for producing the hydrogen. It is reacted with steam at about 1600° F. and atmospheric pressure. After the initial reaction in the furnace, additional steam is added, and the carbon monoxide is converted to carbon dioxide at about 850° F. over a second catalyst. The hydrogen is cooled, and stored in a gas holder. This gas mixture contains about 77 percent hydrogen, with about 18 percent carbon dioxide, and the balance carbon monoxide, methane and nitrogen. The gas is then compressed to about 250 pounds per square inch pressure, and the carbon dioxide is scrubbed out of the gas with monoethanolamine solution[5]. The scrubbed bas ordinarily contains about 95 percent hydrogen together with roughly 1.5 percent methane, 2.0 percent carbon monoxide, 1.5 percent nitrogen (present originally in the natural gas) and a trace of carbon dioxide[10].

Other commercial plants utilizing this process which were installeld prior to 1940 included plants at Port Arthur, Texas; Richmond, California; and Whiting, Indiana[10]. Both natural gas and refinery gases have been used as process materials. In all the plants mentioned above, the hydrogen produced has been utilized for hydrogenating various petroleum products.

The process has also played a major role in providing hydrogen for ammonia synthesis, being utilized in the following synthetic ammonia plants: Hercules Powder Company, Hercules, California, and Louisiana, Missouri (Missouri Ordnance); Alberta Nitrogen Products Limited, Calgary, Alberta; Military Chemical Works, Pittsburg, Kansas (Jayhawk); Lion Oil Refining Company, El Dorado, Arkansas (Ozark); Commercial Solvents Company, Sterling-

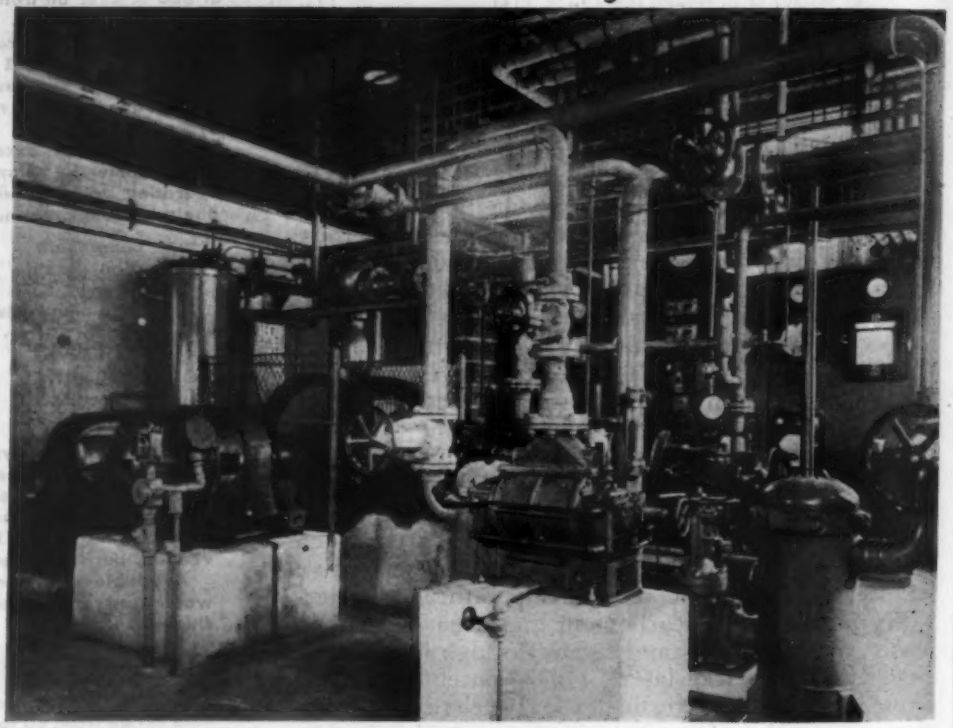


Figure 2. Interior view of hydrogen manufacturing plant

ton, Louisiana (Dixie); and Mathieson Alkali Works, Lake Charles, Louisiana.

In recent years there has been an increasing demand for hydrogen of high purity for various purposes, such as the hydrogenation of edible and inedible oils and fats for shortenings and soap, and the hydrogenation of various organic compounds. Hydrogen has been produced commercially by several processes, including electrolysis of water, which produces oxygen as a byproduct, the steam-iron process, and the catalytic conversion of water gas.

The Girdler Corporation has recently adapted the process for the manufacture of hydrogen from hydrocarbons and steam to the production of hydrogen of high purity. A plant has been installed in New Jersey to manufacture hydrogen for oil hydrogenation. This plant utilizes commercial propane as process material, and produces hydrogen with a purity of 99.9 percent, which has proved to be equal in quality to electrolytic hydrogen for vegetable-oil

hydrogenation. A view of this hydrogen plant is shown in Figure 1. From left to right are two hydrogen holders, propane-storage tank, building housing carbon dioxide scrubbing equipment and hydrogen compressor, two hydrogen heaters, three carbon-monoxide-conversion catalyst chambers and the propane reforming furnace. Figure 2 shows the hydrogen compressor and meter with the instrument panel in the background.

The plant consists of the following sections, which will be described below: propane storage, desulphurization, propane reforming, carbon-monoxide conversion, and carbon dioxide removal.

Propane storage — Propane is stored in a 15,000-gallon horizontal tank, equipped with a steam-heated vaporizer, and supplied with a compressor for unloading propane from tank cars. Propane is used both for process material and for fuel, but it is equally feasible to burn oil or gas for fuel.

Desulphurization — Commercial propane ordinarily is obtained from two sources, namely from natural gasoline plants and from oil refineries. Both types contain small quantities of organic sulphur compounds which must be removed before the propane enters the reformer furnace. The natural-gasoline-plant propane normally contains only mercaptans, while the refinery propane may contain mercaptans, organic sulphides and carbonyl sulphide. Mercaptans may be removed from propane by caustic washing, but this treatment is not effective for removing sulphides. All these organic sulphur compounds may be converted catalytically to hydrogen sulphide by being passed over bauxite or metallic oxides at elevated temperatures. The hydrogen sulphide may then be removed from the propane by scrubbing it with caustic soda solution. In the above-mentioned plant, propane vapors from the storage tank pass through a heater where they are heated to about 700° F. They then pass through a catalyst chamber, cooler, caustic scrubber, and water scrubber.

Propane reforming — Sulphur-free propane vapors from the water scrubber pass through a recording flow controller, are mixed with steam, and enter the top of a Shapleigh[14] reforming furnace. On passing down through the tubes over a nickel catalyst, the propane is converted to hydrogen, carbon monoxide, and carbon dioxide, with a trace of methane the only hydrocarbon remaining in the mixture. The furnace is operated to insure substantially complete conversion of methane.

The effect of temperature upon the reactions for the conversion of methane to carbon monoxide, carbon dioxide and hydrogen with steam may be seen by utilizing the equilibrium constants which have been determined for these reactions. The following values have been calculated from the data by Pitzer:[12]

$$CO + H_2O = CO_2 + H_2 \qquad K_2 = \frac{(CO_2)\,(H_2)}{(CO)\,(H_2O)} \qquad (3)$$

$$CH_4 + H_2O = CO + 3H_2 \qquad K_1 = \frac{(CO)\,(H_2)^3}{(CH_4)\,(H_2O)} \qquad (4)$$

TABLE 1

Methane Conversion Equilibrium Data

Temperature, °F.	K_1	K_2
980	0.033	4.05
1340	27.3	1.38
1500	260	0.97
1550	450	0.89
1600	870	0.82
1700	2640	0.72
1800	4710	0.61

TABLE 2

Equilibrium Compositions in the Methane-Steam Reaction

Component		PERCENTAGE COMPOSITION				
	980° F.	1340° F.	1500° F.	1600° F.	1700° F.	1800° F.
H_2	61	75.8	76.1	76.1	75.9	75.9
CH_4	23	1.0	0.1	0.04	<0.01	<0.01
CO	4	17.2	19.1	19.7	20.3	20.7
CO_2	12	6.0	4.7	4.2	3.8	3.4

Using these equilibrium constants, the equilibrium compositions given in Table 2 were calculated, starting with an initial composition of one mol of methane and two mols of steam. These results are given on a dry basis.

It will be seen that at the higher temperatures, the methane content of the reaction products is negligible, even with the low ratio of steam to methane used in the above calculations. Similar low methane contents are obtained in plant practice on reforming propane at these temperatures. Comparable results have been reported by Rakovskii and Burinova[13] who concluded that at temperatures not exceeding 1472° F., continuous conversion of all gaseous hydrocarbons is possible, leaving a residual amount of hydrocarbons not exceeding 0.3 percent. They employed a supported nickel catalyst with promoters, and used two volumes of steam for each volume of hydrogen produced, which is considerably higher than was used in the calculations given above.

As mentioned above, the overall reactions (equations 1 and 2) which occur in hydrocarbon reforming with steam are endothermic. The heats of reaction for propane given in Table 3 were calculated from the data of Pitzer.[12]

TABLE 3

Heats of Reaction for Propane and Steam

Temperature, °F.	HEATS OF REACTION, BTU PER LB. MOL.	
	Reaction (5) $C_3H_8 + 3H_2O + \triangle H_5 = 3CO + 7H_2$ $\triangle H_5$	Reaction (6) $C_3H_8 + 6H_2O + \triangle H_6 = 3CO_2 + 10H_2$ $\triangle H_6$
1340	230,600	185,700
1500	230,800	187,100
1550	231,000	187,400
1600	231,000	187,600
1700	231,000	188,100
1800	230,700	188,600

Because of the relatively high temperature level at which the reforming operation is carried out, various devices may be employed to effect heat economies, such as waste-heat boilers or superheaters on the exit flue gases and heat exchange between products and feed.

Carbon-monoxide conversion — The product gases from the reformer furnace are mixed with steam to cool them to about 700° F. and are then passed through a catalyst chamber containing a carbon-monoxide-conversion catalyst. The carbon monoxide is largely converted to carbon dioxide according to reaction (3), producing an equivalent amount of hydrogen. The gases then pass through a cooler where the excess steam is condensed, and the gases are cooled to about 100° F. From the cooler the gases pass directly to the CO_2 scrubber.

The water gas shift reaction (3) $CO + H_2O = CO_2 + H_2$ has been studied by many investigators. After summarizing recent data (11) an empirical equation was derived which gives quite accurate results for the equilibrium constant $K_p = \frac{(CO)\,(H_2O)}{(CO_2)\,(H_2)}$

TABLE 4

Water Gas Constant $K_p = \frac{(CO)\ (H_2O)}{(CO_2)\ (H_2)}$

Temperature, °F.	K_p
260	7.1×10^{-4}
440	7.9×10^{-3}
620	3.7×10^{-2}
662	4.8×10^{-2}
752	8.4×10^{-2}
800	11.0×10^{-2}
842	13.4×10^{-2}
932	20.1×10^{-2}

over a wide temperature range. This equation is

$$K_p = 49.5/e^{7,350/(°F.\,+\,460)}$$

Values of this constant at various temperatures are given in Table 4.

Low temperatures favor the complete conversion of carbon monoxide to carbon dioxide. Without catalysts the reaction proceeds only at extremely high temperatures. Many catalysts have been proposed for carrying out this reaction, but Ellis[4] states that iron oxide catalysts with promoters such as a chromate are in almost exclusive use. These catalysts permit the reaction to proceed substantially to equilibrium at temperatures in the neighborhood of 800° F. at space velocities of 100 or more (volumes of carbon monoxide and hydrogen per volume of catalyst per hour).

The water gas shift reaction is exothermic, 16,500 Btu being liberated at 700° F. per pound mol of carbon monoxide reacting. With gas mixtures rich in carbon monoxide, steam injection or intermediate heat exchange or cooling is employed to prevent undue temperature increases.

Carbon dioxide removal — Carbon dioxide is removed from the gas mixture by scrubbing with monoethanolamine solution. This process (the Girbotol Process) has been described elsewhere.[5, 1] An aqueous solution containing 15 to 20 percent monoethanolamine is circulated down through a packed or bubble-tray tower countercurrent to the gas from which the carbon dioxide is being removed. The solution containing carbon dioxide is pumped through heat-exchange equipment to the top of a second tower in which the carbon dioxide is desorbed from the amine solution by steam generated by boiling the solution in a reboiler at the base of the tower. The regenerated solution then is returned to the absorber. The ratio of solution flow to gas flow will depend upon the carbon-dioxide content of the gas being treated, the operating pressure and temperature, the amount of contact provided between gas and solution, the desired carbon-dioxide content of the gas after scrubbing, and the composition of the solution. At atmospheric pressure and 100° F. the carbon-dioxide content of a gas containing 20 percent carbon dioxide may be reduced to 0.1 percent or less by scrubbing it with monoethanolamine solution in a suitable packed or bubble-tray tower with the monoethanolamine solution absorbing from 2 to 4 cubic feet of carbon dioxide per gallon of solution circulated. The steam required for regenerating the amine solution is approximately 1 pound per gallon of solution regenerated.

The carbon dioxide removed from the hydrogen amounts to about 300 cubic feet per 1000 cubic feet of hydrogen. It is recovered substantially pure (99.8 percent) and is available as a useful by-product.

After the carbon dioxide has been removed, the hydrogen contains approximately 1 percent of carbon monoxide. This is removed by passing the hydrogen through two more stages of carbon-monoxide conversion and carbon-dioxide removal. After this treatment the pure hydrogen passes to a gas holder and is then compressed to approximately 150 pounds per square inch, gauge, pressure and delivered to storage tanks.

The following analysis was obtained on purified hydrogen produced during a test run at design capacity:

TABLE 5

Analysis of Purified Hydrogen

COMPONENT	Percent
Carbon dioxide	0.001
Oxygen	0.005
Carbon monoxide	0.001
Methane	0.018
Nitrogen	0.007
Hydrogen	99.968
Total	100.000

The cost of producing hydrogen from propane or other hydrocarbons such as natural gas, refinery gas or butane, will depend upon the cost of these materials as well as utility costs. The process material and utility requirements for producing pure hydrogen by the above process will be approximately as follows per 1000 cubic feet of hydrogen:

TABLE 6

Material and Utility Requirements per 1000 SCF of Hydrogen

MATERIAL	Quantity
Propane, process—gallons	2.75
Fuel (gas or oil)—Btu (gross)	350,000
Steam—pounds	360
Cooling water (30° F. rise)—gallons	1,800
Power—KWH	2
Chemicals—cost in cents	1

The catalysts used are rugged and long lived. Normal catalyst life is one year or more, and replacement cost amounts to 1 to 2 cents per 1000 cubic feet of hydrogen. Labor requirements are small. One operator per shift can run a plant producing from 100,000 to 1,000,000 standard cubic feet of hydrogen per day.

Acknowledgement is made to Dr. F. D. Oldham for calculation of equilibrium data included herein.

REFERENCES

[1] Bottoms, R. R. (to The Girdler Corporation) U. S. Patent Reissue 18,958 (1933) of U. S. Patent 1,783,901 (1930). Mason, J. W., and Dodge, B. F., Trans. Am. Inst. Chem. Eng., **32**, 1-21 (1936). Reed, R. M., and Wood, W. R., Trans. Am. Inst. Chem. Eng., **37**, 363-383 (1941). Storrs, B. D., and Reed, R. M., Trans. A.S.M.E., **64**, 299-302 (1942).

[2] Byrne, P. J., Jr., Gohr, E. J., and Haslam, R. T., Ind. Eng. Chem., **24**, 1129-1135 (1932).

[3] Du Motay, T., U. S. Patents 229,338 and 229,340 (1880).

[4] Ellis, C., "Hydrogenation of Organic Substances," third edition, page 730, D. Van Nostrand Company, New York, (1930).

[5] Gregory, L. B., and Scharmann, W. G., Ind. Eng. Chem., **29**, 514-519 (1937).

[6] Hanks, W. V., Freyermuth, G. H., and Potts, G., (to Standard Oil Development Company) U. S. Patent 2,028,326(1936).

[7] Haslam, R. T., and Russell, R. P., Ind. Eng. Chem. **22**, 1030-1037 (1930).

[8] Mittasch, A., and Schneider, C., (to Badische Anilin & Soda Fabrik), U. S. Patent 1,128,804 (1915).

[9] Mond, L., and Langer, C., British Patent 12,608 (1888).

[10] Murphree, E. V., Brown, C. L., and Gohr, E. J., Ind. Eng. Chem., **32**, 1203-1212 (1940).

[11] Neumann and Kohler, Z. Electrochem., **34**, 218 (1928); Emmett and Schultz, J., Am. Chem. Soc., **52**, 4268 (1930); **55**, 1376 (1933). Kassel, L. S., J. Am. Chem. Soc., **56**, 1838 (1934). Lewis and von Elbe, J. Am. Chem. Soc., **57**, 612 (1935). Hahn, Z. Physik Chem., **44**, 513 (1903). Pitzer, K. S., Chem. Rev. **27**, 37 (1940). Bryant, Ind. Eng. Chem., **23**, 1019 (1931) and **24**, 591 (1932).

[12] Pitzer, K. S., Chem. Rev., **27**, 37-57 (1940).

[13] Rakovskii, E. V., and Burinova, O. A., J. Appl. Chem. (USSR), **14**, 449-465 (1941). Abstracted by Universal Oil Products Company Library Bulletin of Abstracts, **19**, 184 (1944).

[14] Shapleigh, J. H. (to Hercules Powder Company), U. S. Patent Reissue 21,521 (1940) of U. S. Patent 2,173,984 (1939).

[15] Sherwood, T. K., "Absorption and Extraction," pages 220-222, McGraw-Hill Book Company, New York, (1937).

[16] Wietzel, G., Haller, W., and Hennicke, W. (to I. G. Farbenindustrie), U. S. Patent 1,934,836 (1933).

Design of the Goleta Dehydration Plant

RICHARD H. HULL, Pacific Lighting Corporation

ONE of the unique features of this dehydration installation is that it operates as part of an underground storage project for natural gas. Gas from many sources is put into the formation of the Goleta gas field during the summer, so it can be withdrawn as needed during the winter.

Even then demand for the gas varies, with the result that the dehydration plant has three-contact columns, which come into play in keeping with demand.

Design and operation of the unit are similar to requirements for dehydration in natural gasoline manufacture. The paper was delivered before the meeting of the California Natural Gasoline Association, August 2, 1945.

THE dehydration plant is located at Pacific Lighting Corporation's compressor plant site in the Goleta gas field, ten miles west of Santa Barbara, California. Its purpose is the dehydration of the gas which is withdrawn from storage in the field and delivered into the Southern Counties Gas Company's 16-inch-1000 psig line for delivery into the Los Angeles Basin Area.

During the winter, which is the normal withdrawal period, the ground temperatures along the line drop to about 54° F. To prevent water from condensing in the line and also to prevent the probable formation of hydrates, it is necessary to lower the dew point of the gas to a point below the ground temperature. The dehydration plant is designed to handle 150,000,000 cubic feet of gas per 24 hours and to depress the dew point approximately 40° F. below the incoming temperature. This incoming temperature is maintained from about 78° maximum to 70° minimum. If the temperature were allowed to drop below 70° F. there is the possibility of hydrate formation in the saturated gas ahead of the dehydration plant and consequent freezing of the piping. The gas is processed and delivered into the line near this temperature and the 40° depression gives a resultant dew point of about 38° F. maximum which is safely below the ground temperature.

The dehydration plant equipment and piping are designed to operate up to 1050 psig in order that the gas may be processed and metered into the line at 1000 psig. The gas enters the dehydration plant and is reduced from field pressure to about 1025 psig by means of two regulators operating in parallel. The control pressure on the master regulators is taken from the meters downstream from the dehydration plant. This automatically compensates for plant pressure losses so that it is not necessary to juggle the regulated pressure to try to meet the desired delivery pressure. The regulators operate so that a low volume will be handled by one regulator only, with the second regulator opening automatically and the two equalizing when the first has reached near its capacity. An additional controller is set as a safety to prevent the regulators from building the pressure above 1050 psig into the plant.

After the pressure is reduced, the gas passes through cooling coils where it is cooled from field temperature to approximately 78° F. and then through mechanical separators which remove the free condensate. From the separators the gas flows through diethylene glycol contactor towers where it is intimately contacted with the diethylene glycol (called DEG for convenience) which absorbs the water vapor and a portion of the gasoline vapors. From the contactors the dry gas passes through regulators and is metered into the pipe line.

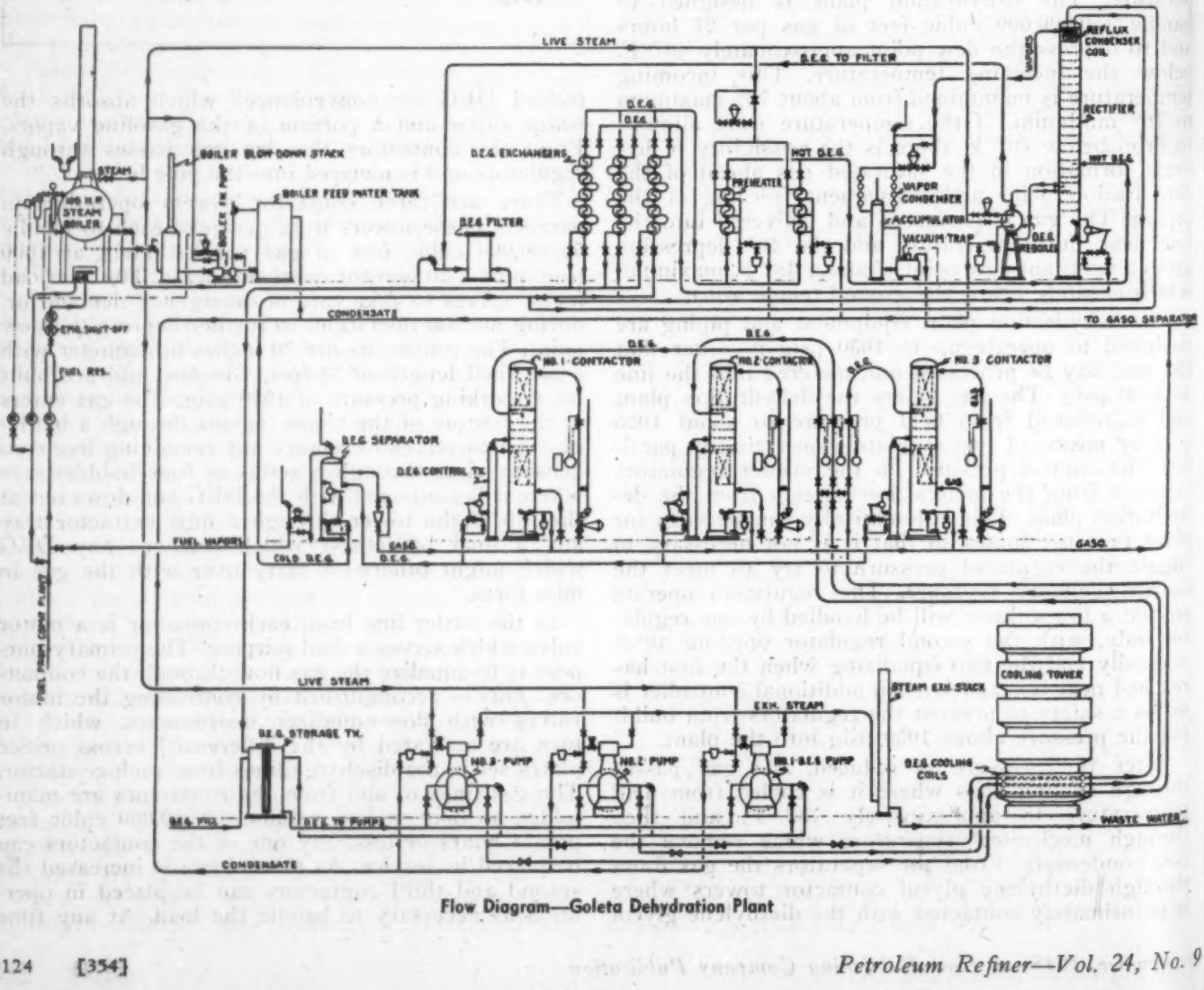
There are three contactor towers operating in parallel. These towers were designed each to handle 50,000,000 cubic feet of gas per 24 hours at 1000 psig, plus a 20 percent overload factor. The overload factor serves to take care of emergency demand or, during normal operation, to further depress the dew point. The contactors are 50 inches in diameter with a net shell length of 33-feet, 7-inches, and are built for a working pressure of 1070 psig. The gas enters at the bottom of the tower, passes through a baffle-nest which serves to remove any remaining free condensate, rises through a series of four bubble-trays where it is contacted with the DEG and flows out at the top of the tower through a mist extractor tray and a final baffle-nest which removes any DEG which might otherwise carry over with the gas in mist form.

In the outlet line from each contactor is a motor valve which serves a dual purpose. The primary purpose is to equalize the gas flow through the contactors. This is accomplished by controlling the motor valves with flow-equalizer instruments, which in turn are activated by the differential across orifice plates set in the discharge lines from each contactor. The gas lines to and from the contactors are manifolded so that on low volume, 50,000,000 cubic feet per 24 hours or less, any one of the contactors can be placed in service. As the volume is increased the second and third contactors can be placed in operation as necessary to handle the load. At any time

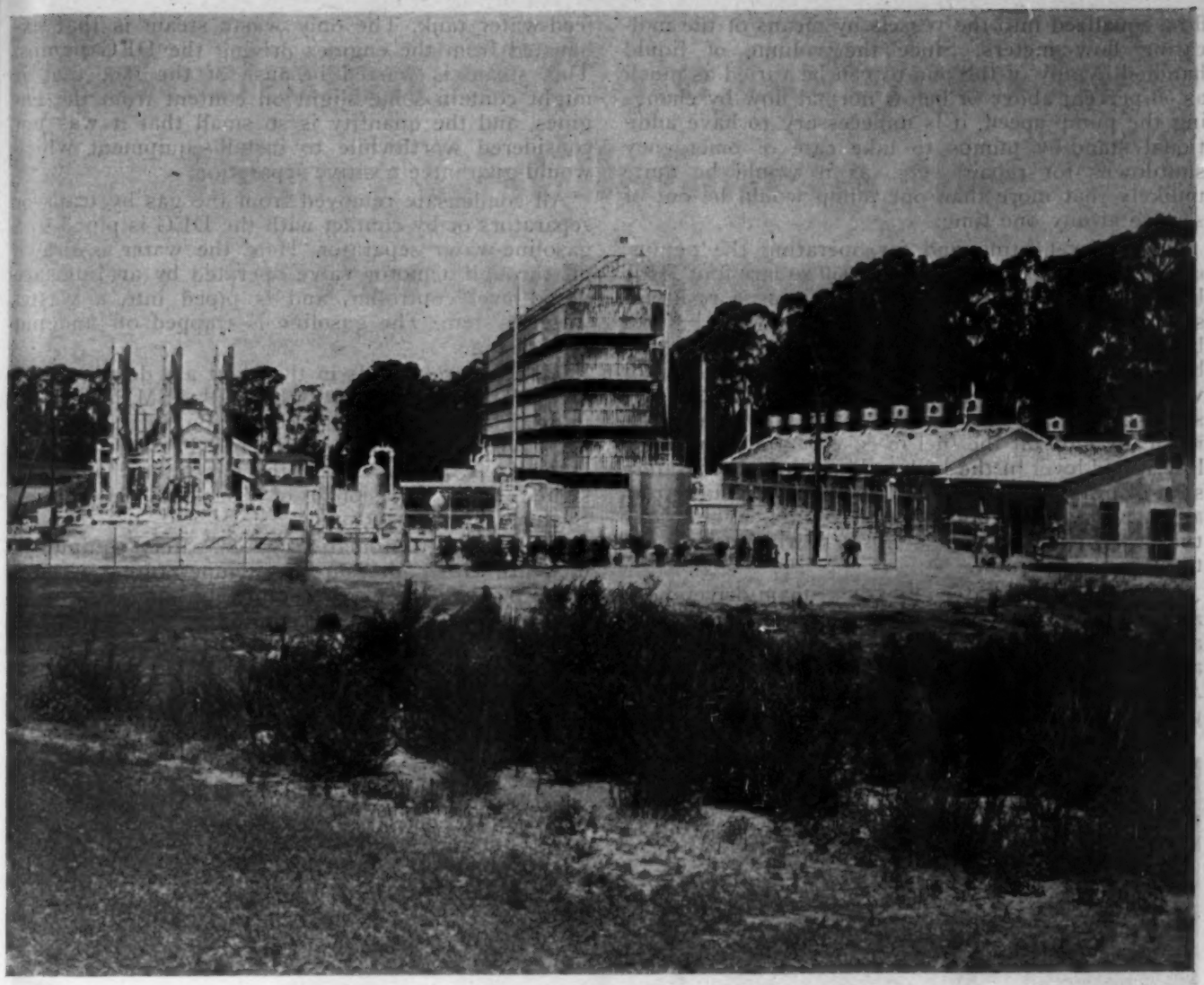
two or three contactors are in service the flow equalizers operate to divide the load equally between them. The second purpose is to maintain a minimum back pressure of approximately 950 psig on contactors. In case the gas pressure in the line is pulled down unexpectedly the resultant increase in volume and velocity through the contactors would probably carry over the DEG with the gas stream and might even be great enough to damage the bubbletrays due to the high differential across them. By holding a high minimum downstream pressure, the back-pressure controllers prevent any large pressure drop through the vessels.

The DEG, combined with water and gasoline, from each contactor flows out into a 16-inch diameter by 13-foot float tank in which the proper level is maintained by means of a liquid-level controller. From the individual float tanks the liquid streams are combined and pass into a gasoline separator tank. Here most of the gasoline separates from the DEG and is drained off through a trap to gasoline storage tanks. A certain amount of wet gas entrained in the DEG from the contactors is also released in the separator. This gas combined with gasoline vapors is released at the top of the vessel through a back-pressure regulator and is piped into the boiler-fuel system. The DEG and water mixture are drawn from the bottom of the separator through a motor valve controlled by a liquid-level controller, which has its float set at the interface between the DEG surface and the gasoline in the tank. It is then piped into a series of heat exchangers consisting of three parallel banks, each containing five G-Fin exchangers. From the line between the separator and the heat exchangers a portion of the cold DEG is bypassed through a coil in the top of the rectifier and then is returned to combine with the main stream into the exchangers. The cold coil in the top of the rectifier condenses rising vapor which serves as a reflux. In exchange the DEG passing through the coil absorbs an equal amount of heat. In the exchangers the DEG receives its first stage of heating from counter-flowing hot DEG returning from the rectifier to storage. The warmed DEG then passes through a set of preheaters, consisting of two parallel banks, each containing three G-Fin exchangers, where it is heated by steam to a temperature sufficient to evaporate the entrained water and any remaining small amount of gasoline. The outgoing temperature of the DEG is controlled by a temperature-operated motor valve set in the steam line to the pre-heaters with a control bulb in the DEG line. This motor valve can be set to maintain any desired temperature in the DEG and it achieves this result by increasing or decreasing the quantity of steam admitted to the pre-heaters.

From the pre-heaters the flashing mixture of DEG and water vapor is piped into the rectifier, or still. This is a column 26 inches in diameter by 29 feet 10-inch net shell length, built for working pressure of 50 psig, which contains 14 bubble-trays and 6 trays of other types. Most of the water vapor is



Flow Diagram—Goleta Dehydration Plant



General view of Goleta Dehydration Plant

separated from the DEG in the bubble-trays when it first enters the column. The lean DEG is then drawn off and passed through a reheater, which is a 13-inch x 10-foot horizontal shell and tube type of heat exchanger, where its temperature is again raised by steam to a point where any remaining water is vaporized. The temperature of the DEG from the reheater is fixed by a temperature control regulator set in the steam line to the reheater with the control bulb in the outgoing DEG line. From the reheater the DEG is returned to the lower part of the rectifier to allow this final vapor to escape.

The water vapors, which are driven off in the rectifier, rise through the column and when they contact the cold condenser coil in the top, a portion of them are condensed as a reflux. The balance of the vapors are released through a back-pressure regulator which maintains the desired operating pressure on the vessel. These vapors are then condensed in a set of air-cooled fin-tube exchangers and the liquid collected in an accumulator. Here the quantity of liquid can be checked and it can be tested for any content of DEG, gasoline, etc., which might carry over with the vapors, thus showing whether or not the rectifier is properly operating. The hot lean DEG is released from the bottom of the rectifier through a motor valve operated by a liquid-level controller, flows through the DEG heat exchangers where it imparts heat to the incoming cold DEG-water mixture, and then is piped to a storage tank.

In order to remove any dirt, carbon, etc., which may accumulate in the DEG, the line between the reheater and the rectifier is tapped and a small stream of DEG is drawn off and passed through a filter. This filtered DEG is then piped directly to the storage tank.

The DEG is drawn from the storage tank by three steam-engine-driven 1½x2-inch vertical triplex pumps, operating in parallel. It is pumped through three parallel banks of atmospheric cooling sections where it is cooled to approximately the temperature of the gas being treated, and then enters the contactors through indicating flow meters.

There are two manifolds in the DEG piping, one at the pump discharge and one in front of the contactors, which make the DEG system completely flexible. Normally each pump puts liquid directly through one bank of coils and into one contactor with the volume being determined by the speed of the pump. However, in case any pump, bank of coils, or contactor must be out of service the manifold system allows any of the pumps to put DEG through any of the coils into any of the contactors. In case the DEG streams have to be combined, as in the case of two pumps serving three contactors, the liquid is separated in the manifold at the contactors and the

flow equalized into the vessels by means of the indicating flow meters. Since the volume of liquid handled by any of the pumps can be varied as much as 50 percent above or below normal flow by changing the pump speed, it is unnecessary to have additional stand-by pumps to take care of emergency shutdowns for repairs, etc., as it would be quite unlikely that more than one pump would be out of service at any one time.

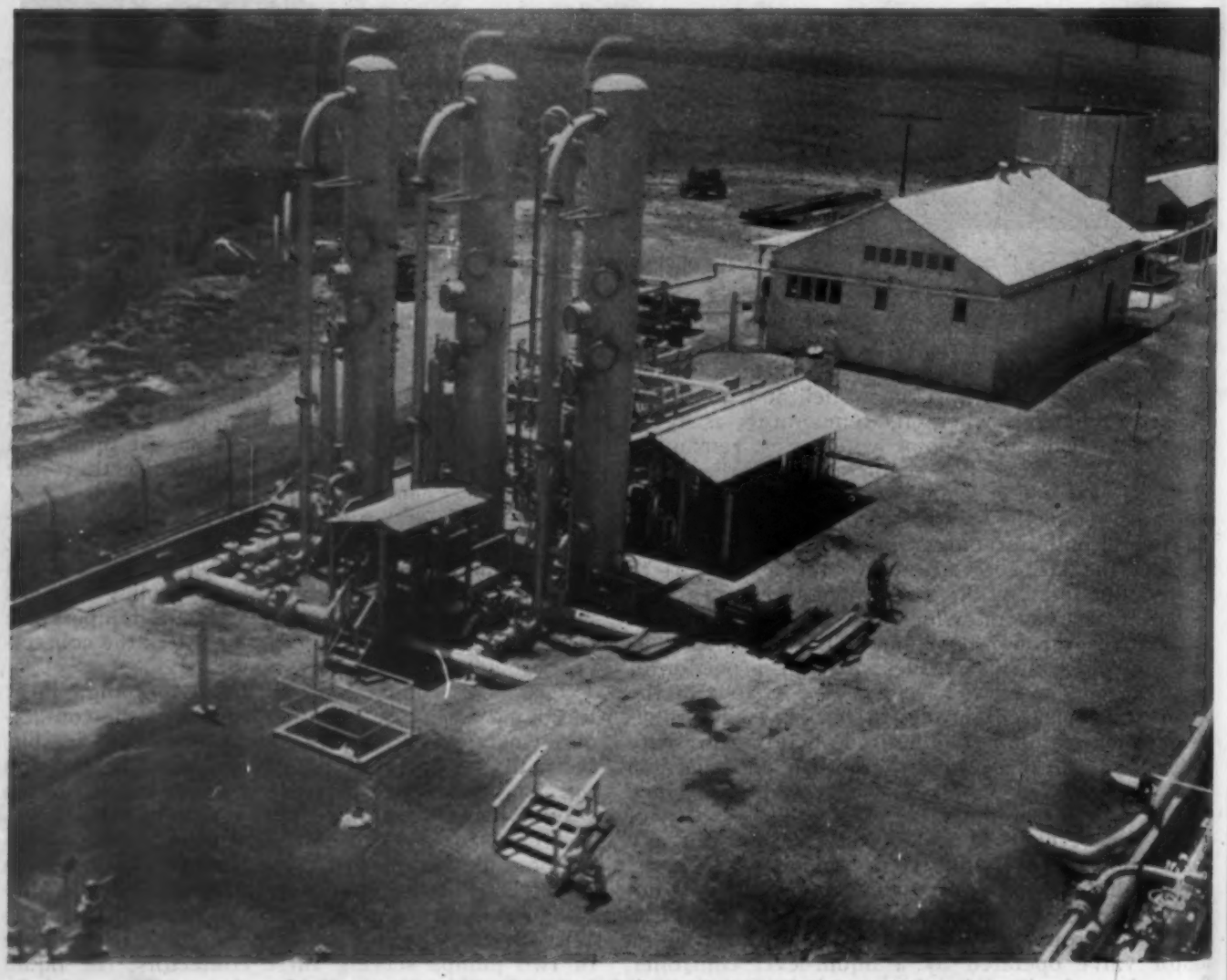
Steam for heating and for operating the pumps, engines, etc., is generated in a 1050 square foot HRT boiler, operating at 150 psig and giving a resultant steam temperature of approximately 366° F. The boiler fuel is automatically controlled from the boiler pressure by means of a pilot-operated motor valve set in the fuel line. An additional motor valve set in the fuel line serves as a safety valve and automatically cuts off the fuel in case of too high or too low water level in the boiler. The pilot of the safety shut-off valve is activated by steam pressure from a float valve in the boiler-water column. At the same time the safety shut-off is closed a whistle is blown to warn the operator.

The boiler-feed-water pump is a steam-driven horizontal duplex. The speed of the pump is controlled by a pilot-operated motor valve in the steam feed line, activated by a liquid level controller on the boiler. All condensate from the main steam line, headers, pre-heaters, and re-heater is returned to the boiler-feed-water tank. The only waste steam is that exhausted from the engines driving the DEG pumps. This steam is wasted because of the fact that it might contain some slight oil content from the engines, and the quantity is so small that it was not considered worthwhile to install equipment which would guarantee positive separation.

All condensate removed from the gas by traps or separators or by contact with the DEG is piped to a gasoline-water separator. Here the water is drawn off through a motor valve operated by an interface liquid-level controller, and is piped into a waste-water system. The gasoline is trapped off and put into storage.

All pressure vessels in the plant are designed and built in accordance with the API-ASME code for unfired pressure vessels. All piping is designed in accordance with ASA Code for Pressure Piping, listed as ASA B31.1-1942, the gas piping being designed under Division 1 of "Gas and Air Piping Systems."

All controls, automatic devices, safety equipment, etc., are either pressure or temperature operated. This makes the plant completely independent of any electrical service, except for lighting purposes. This is advantageous in that the demand for the plant is in the wintertime when due to storms, etc., there is more likelihood of electrical failures in the rural systems.



Contactor gas piping, Pacific Lighting Corporation's Goleta Dehydration Plant

Calculation of Plate Columns for Binary Distillation by the Ponchon Method

ROBERT R. WHITE
Assistant Professor, Department of Chemical Engineering
University of Michigan

THEORY of the Ponchon Method and its application to the calculation of simple columns was printed in the August issue of Petroleum Refiner. This concluding part of the paper deals with special applications of the method such as open steam, multiple feed and multiple products column.

Partial Condensers

Where a partial condenser is used, only a portion of the vapors, sufficient to form the reflux liquid, are condensed and the distillate product is withdrawn as a vapor, the receiver functioning as a vapor-liquid separator. The enthalpy-composition diagram for this operation is shown in Figure 6.

The coordinates of the difference point, d, for the rectifying section are unchanged, i.e., y_D, $H_D - Q_D$. The reflux liquid, R, where it is in equilibrium with the distillate product, is located on the liquid saturation line at the end of the equilibrium tie line from

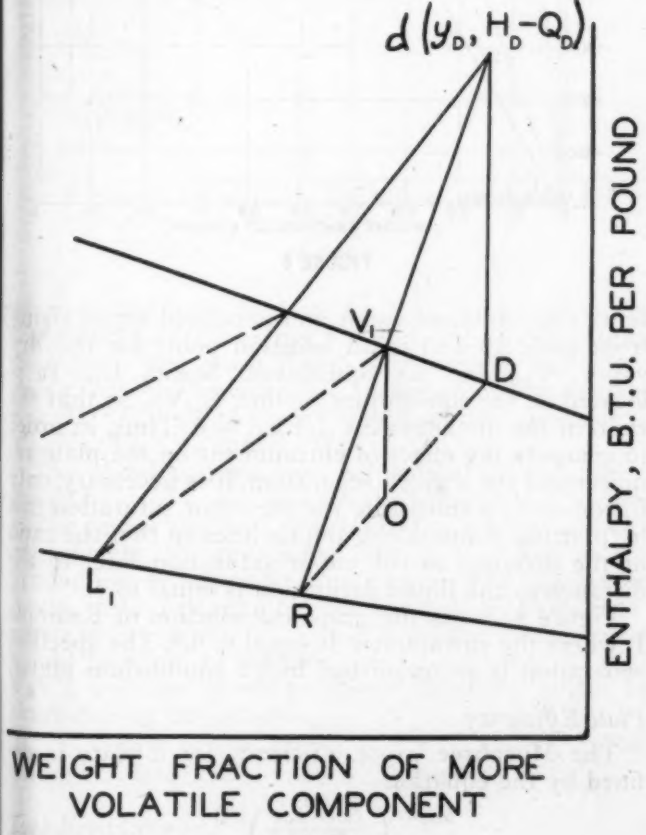


FIGURE 6

the distillate product, D, on the vapor saturation line, and the points V_1, R and d lie on a straight line. The point, O, which represents the sum of the reflux liquid and the distillate product, lies directly below the point V_1. The reflux ratio R/D is equal to the ratio of the distances OD/RO, or dV_1/V_1R.

Open Steam

The still or reboiler is subject to the most severe corrosive conditions, requires considerable maintenance, and is expensive to install. Where water is the less volatile component, the still may be eliminated by feeding open steam under the bottom plate and by withdrawing the overflow from the bottom plate as the bottom product. The calculation of the plate requirement for columns operated with open steam is shown in Figure 7 which is the graphical solution to the following problem.*

Example No. 2. A fractionating column is to be computed to separate a mixture containing 42.2 weight-percent ethanol,

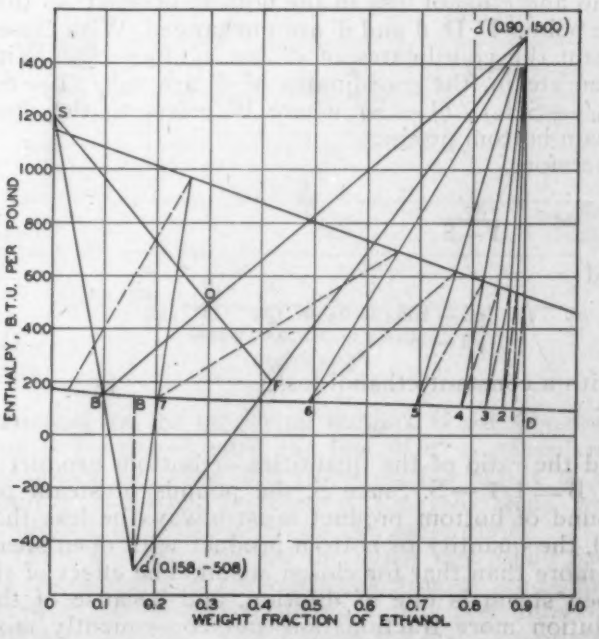


FIGURE 7

* In the interest of brevity, the following example problems have been limited to the calculation of the number of equilibrium plates.

balance water, into a distillate product containing 90.0 weight-percent ethanol and a bottom product containing 10.0 weight-percent ethanol. The enthalpy of the entering feed will be 200 Btu per pound; the enthalpy of the distillate product and reflux liquid will be 50.0 Btu per pound. Open steam having an enthalpy of 1200 Btu per pound will be fed under the bottom plate at the rate of 0.416 pounds per pound of feed. How many equilibrium plates must be provided?

The feed is represented by point F, the bottom product by point B′, the steam by point S, and the distillate product and reflux liquid by point D. The total feed to the column is represented by point O, which represents the sum of the feed stream, F, and the open steam, S, so located that the ratio of the distances, OF/OS equals 0.416 pounds of steam per pound of feed. The point O must also be the addition point for the bottom product, B′, withdrawn from the column and the distillate product minus the energy added in the condenser, represented by the point d, (x_D, $h_D - Q_D$). The point d is located by extending the line BO to the value $x_D = 0.90$.

The point d′ represents the difference between the liquid and vapor passing one another in the stripping section, and the difference between the steam, S, and the bottom product, B′. Thus, the point d′ lies on the extension of the line B′S. the point d′ also represents the difference between the feed stream, F, and the distillate product minus the energy in the condenser, represented by the point d, (x_D, $h_D - Q_D$). The point d′, therefore, lies on the extension of the line Fd. Thus, point d′ is located at the intersection of the lines B′S and Fd. The plate to plate calculation is made as described previously and as indicated in Figure 7, the number of equilibrium plates required is 7.7.

The coordinates of the point d′ may be shown from the geometry of the figure to be $x_B'/(1-S)$, $(h_B' - SH_S)/(1-S)$ where S is the pounds of steam per pound of bottom product and H_S is the enthalpy of the steam, Btu per pound.

Comparison of Open- and Closed-Steam Operation

It is of interest to compare open-steam operation with closed-steam operation by considering the production of the distillate product of Example No. 2 from the same feed while maintaining the same reflux ratio and ethanol loss in the bottom product, so that the points F, D, d and d′ are unchanged. With closed steam the coordinates of d′ are x_B, $h_B - Q_B$. With open steam, the coordinates of d′ are $x_B'/(1-S)$, $(h_B' - SH_S)/(1-S)$ where B′ refers to the open steam bottom product.
Therefore,

$$\frac{x_B'}{1-S} = x_B \tag{14}$$

and

$$\frac{h_B' - SH_S}{1-S} = h_B - Q_B \tag{15}$$

With a constant ethanol loss,

$$Bx_B = B'x_B' \tag{16}$$

and the ratio of the quantities of bottom product is $B'/B = 1/1-S$. Since S, the pounds of steam per pound of bottom product must always be less than 1.0, the quantity of bottom product with open steam is more than that for closed steam. The effect of the open steam is one of dilution, and because of this dilution more fractionation and consequently more plates are required. This is shown in Figure 7, where 7.3 equilibrium plates are required with closed steam as compared to 7.7 for open steam.

Entrainment

Entrainment is defined as the pounds of liquid, e, carried by 1 pound of vapor as it rises from a plate. A pound of vapor which rises from an equilibrium plate carries with it e pounds of liquid which is in equilibrium with the vapor. The point E in Figure 8 represents the combined vapor and entrained liquid rising from plate 10 and is an addition point for the dry vapor, V_{10}, and its equilibrium liquid, L_{10}. It is located on the equilibrium tie line, $L_{10}V_{10}$, so that the ratio of the distances $EV_{10}/EL_{10} = e$. Thus, in order to compute the effect of entrainment on the plate requirement for a given separation, it is necessary only to construct a substitute for the vapor saturation line by plotting points along the tie lines so that the ratio of the distance to the vapor saturation line, to the distance to the liquid saturation is equal to e.

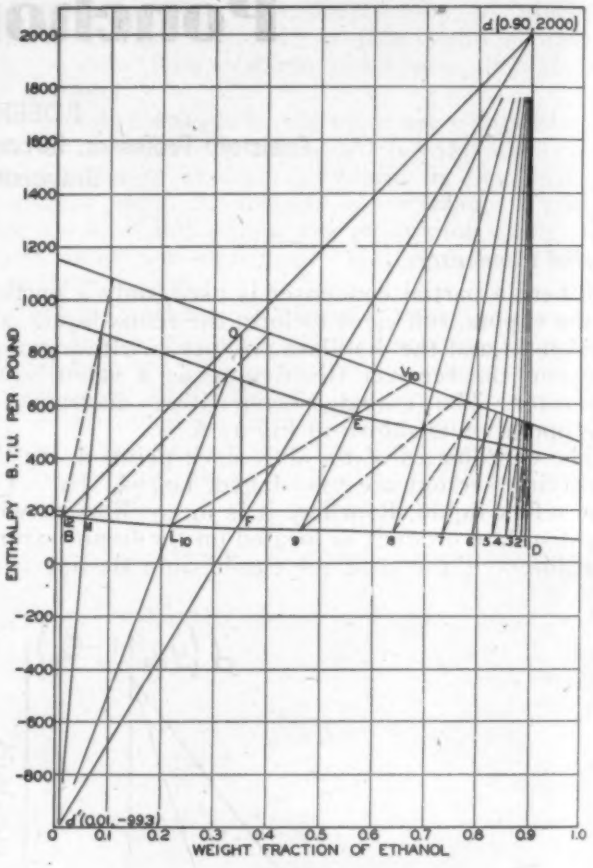


FIGURE 8

Figure 8 shows the graphical solution of Example 1, where the entrainment is equal to 0.3. The specified separation is accomplished by 12 equilibrium plates.

Plate Efficiency

The Murphree vapor efficiency for a plate is defined by the equation

$$M_n = \left(\frac{y_n - y_{n+1}}{y_n' - y_{n+1}}\right)100 \tag{17}$$

The application of plate efficiency in computing plate requirement is shown in Figure 9. It is convenient to begin the plate-to-plate construction at the still.

In Figure 9, V_B represents the still vapors, which may usually be assumed to be in equilibrium with the

still liquid; L_m, the liquid on the bottom plate; V_m, the vapor rising from the bottom plate, V'_m the vapor in equilibrium with L_m, etc. The point, V_B is located at the end of the tie line from the bottom product composition and L_m and V'_m are determined as previously described. The vapor leaving the bottom plate, V_m, is located on the straight line $V_B V'_m$ so that the ratio of the distances $V_m V_B / V'_m V_B$ equals M_m according to Equation (17). The liquid on the

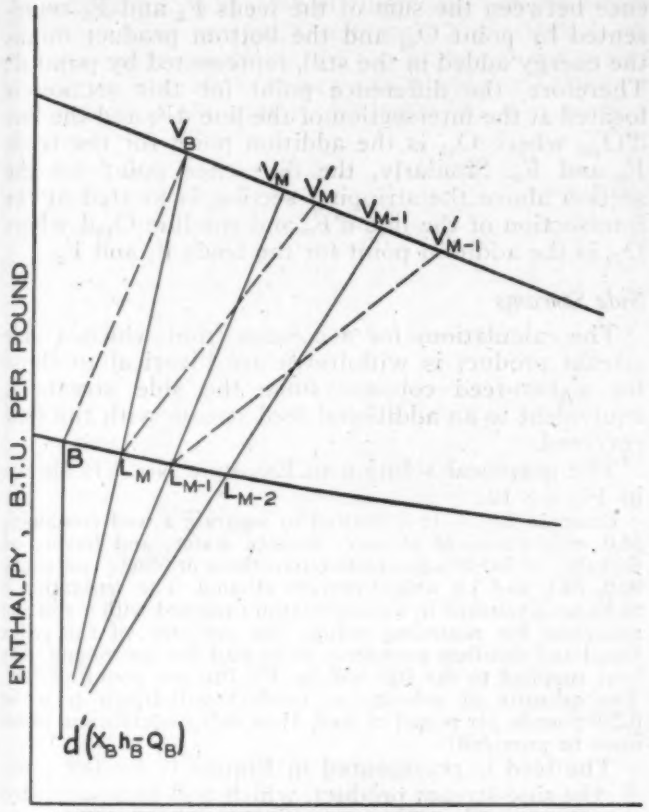


FIGURE 9

second plate from the bottom, L_{m-1}, is located by the intersection of the line $d'V_m$ with the liquid saturation line. The point V_{m-1}, representing the vapor rising from the second plate, is located on the straight line $V_m V'_{m-1}$ so that the ratio of the distances $V_{m-1} V_m / V'_{m-1} V_m$ equals M_{m-1}.

The above construction is identical to that which would be used to account for the passage of a portion of the vapor through the liquid on a plate without any change, the remaining portion resulting in the production of vapor in equilibrium with the liquid on the plate. For example, the fraction of "by-passed" vapor in the vapor, V_m, rising from the bottom plate would be equal to the ratio of the distances $V_m V'_m / V_B V'_m$ and the Murphree plate efficiency might be expressed by the relation

$$M = (1 - \phi)\ 100 \qquad (18)$$

where ϕ = fraction of vapors "by-passed."

Two Feed Columns

The calculation of plate requirement in two feed columns may be explained most conveniently by reference to Example No. 3, the solution to which is shown in Figure 10.

Example No. 3. It is desired to separate 258 pounds per hour of a feed, F_1, having zero enthalpy and containing 74.0 weight-percent ethanol, balance water, and 742 pounds per hour of a feed, F_2, having an enthalpy of 702 Btu per pound and containing 47.1 weight-percent ethanol, balance water, into two products containing 90.0 and 1.0 weight-percent ethanol. The heat supplied to the still will be 386 Btu per pound of combined feed. The reflux liquid and distillate product will have an enthalpy of 50.0 Btu per pound. How many equilibrium plates must be provided in the column?

Points F_1 and F_2 in Figure 10 represent the two feeds. Point O is the addition point for the two feeds and is located on the line F_1F_2 so that the ratio of the distances $OF_2/OF_1 = F_1/F_2 = 258/742$. The energy added in the still per pound of combined feed is represented by the distance OO′ (386 Btu per pound), the point O′ representing the combined feeds plus the energy added in the still per pound of $(F_1 + F_2)$. Point O′ represents also the sum of the bottom product, B, and the distillate product minus the energy added in the condenser, d, $(x_D, h_D - Q_D)$. The difference point, d, for the rectifying section is located by extending the line BO′ to the value $x_D = 0.90$. The difference point d′ for the stripping section is located by extending the line dO to the value $x_B = 0.01$.

It is now possible to begin the plate to plate con-

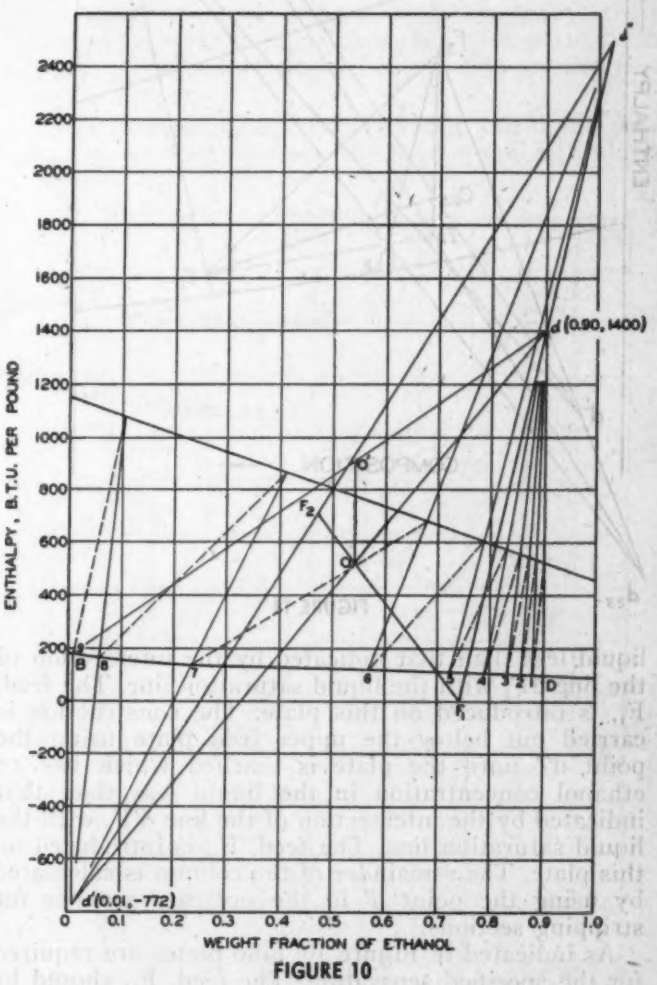


FIGURE 10

struction for the rectifying section. If this construction is continued until the line dOd′ is passed and continued by using the point d′, the result is the number of plates required if the two feeds were combined and introduced on the same plate.

The difference between the vapor and liquid passing one another in the middle section of the column between the two feed plates equals the difference between the upper feed, F_1, and the distillate product

minus the energy added in the condenser. It also equals the difference between the lower feed, F_2, and the bottom product minus the energy added in the still. Therefore, the difference point d'' for the middle section is located at the intersection of the line dF_1 with the line $d'F_2$.

The plate-to-plate construction for the rectifying section is carried out using point d, until the plate is reached which has an ethanol concentration in the liquid less than that indicated by the intersection of the line dF_1 with the liquid saturation line. The feed, F_1, is introduced on this plate. The construction is carried out below the upper feed plate using the point d'' until the plate is reached which has an ethanol concentration in the liquid less than that indicated by the intersection of the line $d'F_2$ with the liquid saturation line. The feed, F_2, is introduced on this plate. The remainder of the column is calculated by using the point d' in the ordinary manner for stripping sections.

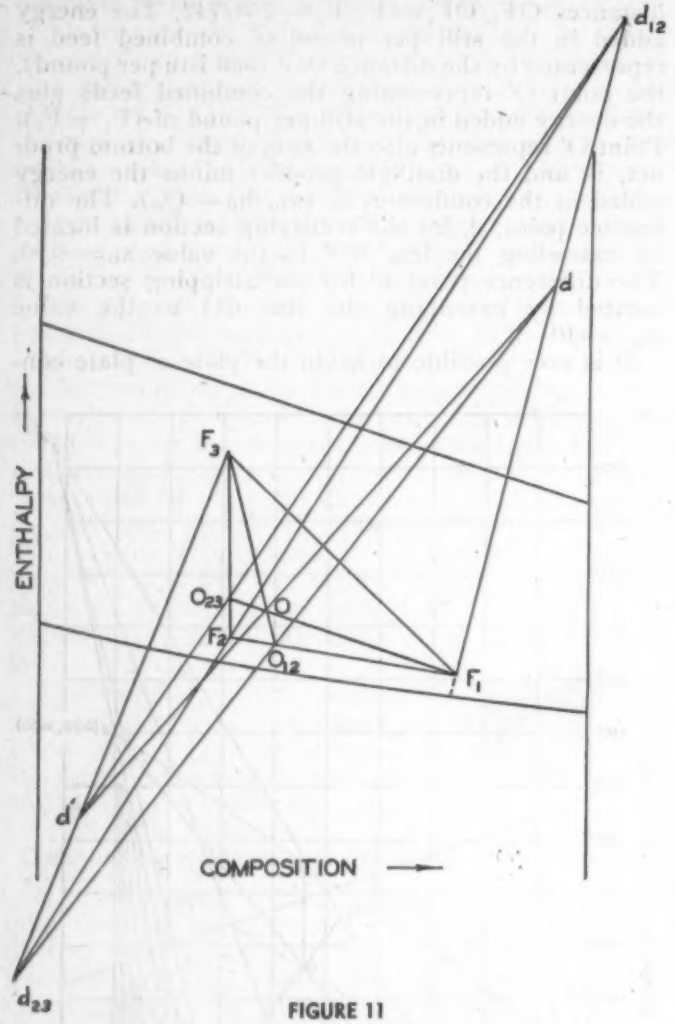


FIGURE 11

As indicated in Figure 10, nine plates are required for the specified separation. The feed, F_1, should be introduced on plate 5 and feed, F_2, on plate 7.

It should be pointed out that in some cases the lines dF_1 and $d'F_2$ are parallel. This condition arises when the quantity of liquid in the section between the feed plates equals the quantity of vapor.

Three Feed Columns

The graphical construction used to determine the difference points for the four sections of a three-feed column is shown in Figure 11. The three feed streams are represented by the points F_1, F_2, and F_3. The combined feed is represented by point O, the addition point for F_1, F_2, and F_3. Points d and d' are the difference points for the rectifying and stripping sections of the column respectively. The difference between the vapor and liquid passing one another in the section below the rectifying section equals the difference between the upper feed, F_1, and the distillate product minus the energy added in the condenser, represented by the point, d. It also equals the difference between the sum of the feeds F_2 and F_3 represented by point O_{23} and the bottom product minus the energy added in the still, represented by point d'. Therefore, the difference point for this section is located at the intersection of the line dF_1 and the line $d'O_{23}$, where O_{23} is the addition point for the feeds F_2 and F_3. Similarly, the difference point for the section above the stripping section is located at the intersection of the line $d'F_3$ and the line $O_{12}d$ where O_{12} is the addition point for the feeds F_1 and F_2.

Side Streams

The calculations for a column from which a side stream product is withdrawn are identical to those for a two-feed column. since the side stream is equivalent to an additional feed stream with the flow reversed.

The graphical solution to Example No. 4 is shown in Figure 12.

Example No. 4. It is desired to separate a feed containing 56.0 weight-percent ethanol, balance water, and having an enthalpy of 300 Btu per pound, into three products containing 90.0, 70.4, and 1.0 weight-percent ethanol. The separation is to be accomplished in a plate column equipped with a still and apparatus for returning reflux. The enthalpy of the reflux liquid and distillate product is to be 60.0 Btu per pound. The heat supplied to the still will be 378 Btu per pound of feed. The quantity of side-stream product withdrawn is to be 0.290 pounds per pound of feed. How many equilibrium plates must be provided?

The feed is represented in Figure 12 by the point F; the side-stream product, which will be a saturated liquid, is represented by the point D_2 located on the liquid saturation line. The point O is difference point for the feed and side stream and is located on the line FD_2 so that the ratio of the distances, $OF/OD_2 = 0.290$.

The heat supplied to the still is 373 Btu per pound of feed or $373/(1.0 - 0.290) = 532$ Btu per pound of feed less side stream, $F - D_2$. The energy added in the still per pound of feed less side stream is represented by the distance OO' (532 Btu per pound) and the point O' represents the sum of the feed less the side stream and the energy added in the still per pound of feed less side stream. Point O' also represents the sum of the bottom product, B, and the distillate product minus the energy added in the condenser. Thus the difference point, d, for the rectifying section is located by extending the line BO' to the value $x_D = 0.90$. The difference point d' is located by extending the line dO to the value $x_B = 0.01$. The point, d'', which represents the difference between the liquid and vapor passing one another in the section between the draw-off plate and the feed plate, is located at the intersection of the lines dD_2 and $d'F$, since the side stream is withdrawn from a plate above the feed plate. Where the side stream is withdrawn from a plate below the feed plate the point d'' is located at the intersection of the lines dF and $d'D_2$.

The plate to plate construction is carried out as described previously, using the point, d, for the rectifying section, the point, d'', for the section be-

tween the feed and draw-off plates and the point, d', for the stripping section. As indicated in Figure 12, 9.4 equilibrium plates are required, the side stream being withdrawn from the fifth plate. The quantity of distillate and bottom products per pound of feed are 0.392 and 0.318 respectively.

Side Stream Recirculation

A problem which is associated with the withdrawal of a side stream is that of controlling side-stream composition. When the distillate and bottom-product compositions are fixed, one must accept what compositions are available on the plates of the column with the particular reflux ratio being used. For instance, if in illustrative Example No. 4 it were de-

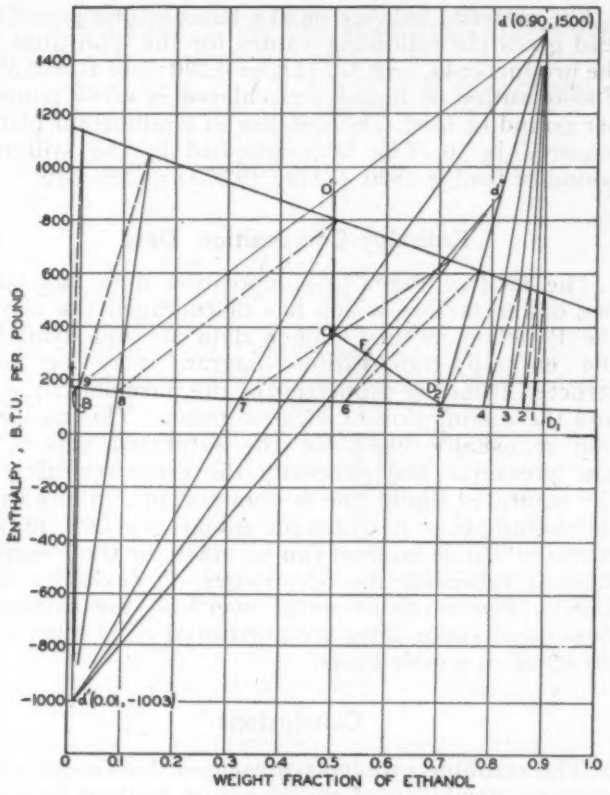


FIGURE 12

sired to obtain a side stream containing 75.0 weight-percent ethanol while making a 90.0-percent distillate and a 1.0-percent bottom product, it would be possible to obtain this product by increasing the reflux ratio until the composition of the liquid on the fourth plate was 75.0 percent ethanol or by decreasing the reflux ratio until the composition of the liquid on the fifth plate was 75.0 percent ethanol.

It is also possible to control side-stream composition at reflux ratios where ordinarily no plate of the column has liquid of the desired composition, by recirculating a portion of the side stream to the plate above the draw-off plate. The effect of the recirculation is to divide the column into four sections; the rectifying section, a recirculation section between the draw-off plate and the plate above, a middle section between the feed and draw-off plates, and finally the stripping section.

Example No. 5. The feed of Example No. 4 is to be separated into distillate and bottom products containing 90.0 and 1.0 weight-percent ethanol, and a side stream containing 75.0 percent ethanol is to be made, using the same reflux ratio as was used in Example No. 4, by recirculating hot side stream to the plate above the draw-off plate. The enthalpy of the reflux liquid and distillate product is to be 60.0 Btu per pound and the quantity of side-stream product withdrawn is to be 0.290 pounds per pound of feed. How many plates are required and how much heat must be supplied to the still?

The graphical solution to Example No. 5 is shown in Figure 13.

The point, d, for the rectifying section will have the same cordinates as in Example No. 4, Figure 12, since the reflux ratio is the same. The point O, representing the feed less side stream, is located on the extension of the line FD_2 so that the ratio of the distances $OF/OD_2 = 0.290$. The difference point, d', for the stripping section is located on the extension of the line dO at the value $x_B = 0.01$. The difference point d'', for the section between the feed and draw-off plates is located at the intersection of the lines D_2d and d'F.

The plate-to-plate construction is carried out for the rectifying section until the composition of the liquid on the fourth plate is determined as 0.779. It is now apparent that an additional plate in the rectifying section will have a liquid composition of less than 0.75 weight-percent ethanol. It is necessary, therefore, to recirculate liquid from the fifth plate to the fourth plate and to withdraw the side stream from the fifth plate.

The difference between the vapor and liquid passing one another between the fourth and fifth plates,

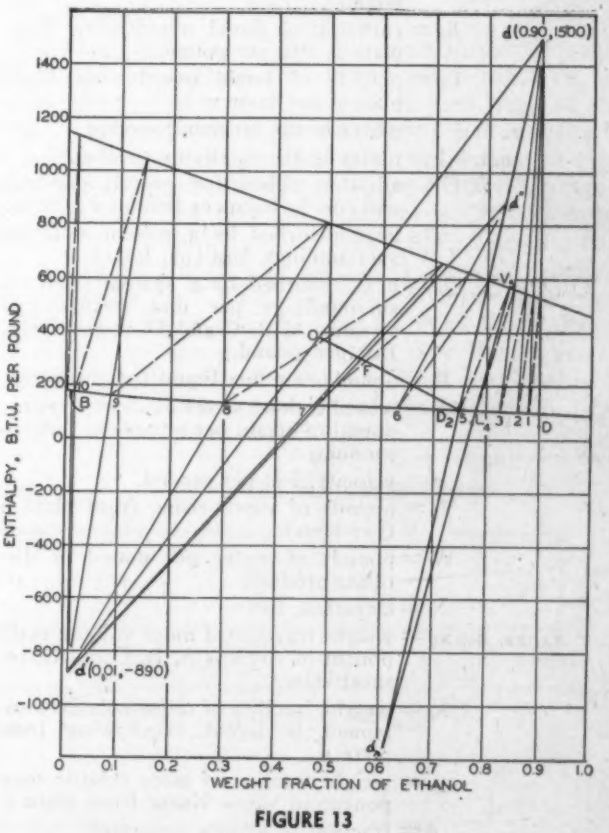


FIGURE 13

represented by point d_r, is equal to the difference between the recirculated side stream fed to the fourth plate, represented by point D_2, and the distillate product minus the energy added in the condenser, represented by point d. The point d_r, will therefore lie on the line dD_2. It must also lie on the line L_4V_5, where L_4 represents the liquid leaving the fourth

Nomenclature

A, B, C = identification symbols for streams shown in Figure 1; also denotes pounds per hour of these streams.
a, b, c = points on enthalpy-composition diagram representing streams A, B, and C, respectively (Figures 2, 3 and 4).
B = pounds of bottom product per hour.
B′ = pounds of bottom product per hour when open steam is used.
D, D_1 = pounds of distillate product per hour.
D_2 = pounds of side-stream product per hour.
d = difference point for rectifying section.
d′ = difference point for stripping section.
D″, d_r = difference points for sections of fractionating columns other than the rectifying and stripping sections.
F, F_1, F_2, F_3 = pounds of feed streams per hour.
g = acceleration of gravity, feet per second per second.
H = enthalpy of vapor streams, Btu per pound.
H_a, H_b, H_c = enthalpy of streams A. B and C, respectively, Btu per pound.
H_n = enthalpy of vapor rising from plate n, Btu per pound.
h = enthalpy of liquid streams, Btu per pound.
h_B = enthalpy of bottom product, Btu per pound.
h_D = enthalpy of distillate product, Btu per pound.
h_n = enthalpy of liquid overflowing from plate n, Btu per pound.
L_n = pounds of liquid overflowing from plate n per hour.
m, m + 1 = plates in the stripping section.
n, n + 1 = plates in the rectifying section.
O, O′ = addition points for overall material and energy balances around a column.
q = heat absorbed by a system from its surroundings, Btu (per hour).
Q_A, Q_B, Q_C, Q_D = heat absorbed by a system from its surroundings per unit quantity of streams A, B, C and D, respectively, Btu per pound.
R = pounds of reflux liquid (per hour).
S = identification symbol for steam; pound of steam per pounds of bottom product.
u = velocity, feet per second.
V_n = pounds of vapor rising from plate n (per hour).
W = pounds of water per pound of distillate product.
X = elevation, feet.
x_A, x_B, x_C, x_D = weight fraction of more volatile component in streams A, B, C and D, respectively.
x_n = weight fraction of more volatile component in liquid overflowing from plate n.
y_n = weight fraction of more volatile component in vapor rising from plate n.
ϕ = fraction of vapors by-passed.

plate and V_5 the vapor rising from the fifth plate. The point L_4 is located from the plate-to-plate construction in the rectifying section and the point V_5 must represent the vapor in equilibrium with the liquid containing 75.0 weight-percent ethanol. The point d_r is thus located by the intersection of the lines dD_2 and L_4V_5 and has the coordinates (0.612, −1140).

The ratio of the quantity of liquid recirculated to quantity of the distillate product is equal to the ratio of the distances d_rd/d_rD_2. The ratio of the side stream product to the distillate product is equal to the ratio of the distances dd''/D_2d'' and the ratio of liquid recirculated to the side stream product is equal to the ratio of the distances $\frac{d_rd}{d_rD_2}\left(\frac{dd''}{D_2d''}\right) = 2.64$

The material balance on the basis of one pound of feed gives the following values for the quantities of the products: $D_1 = 0.377$; $D_2 = 0.290$; and $B = 0.333$. The quantity of liquid recirculated is 0.766 pounds per pound of feed. The number of equilibrium plates required is 10. The heat supplied to the still per pound of feed is $(890 + 179)\ (0.333) = 356$ Btu.

Enthalpy-Composition Data

The lack of enthalpy-composition data has been one of the factors which has discouraged the use of the Ponchon method. When data are not available the enthalpy-composition diagram may be constructed from the properties of the pure constituents and the assumption of ideal solutions. This assumption is usually valid for the saturated vapors at low pressures and generally the error resulting in the saturated liquid line is unimportant. In any case, the assumption of constant molal overflow in the McCabe-Thiele method can be made for the Ponchon method retaining its advantages of flexibility and clarity. For constant molal overflow, the saturated liquid and vapor lines are horizontal on a chart constructed on a mole basis.

Conclusions

The example problems presented demonstrate the extreme flexibility of the Ponchon method for computing plate columns. The concept of addition and difference points eliminates the necessity for involved algebraic manipulation regardless of the complexity of the operation under consideration. The representation of a fractionating column on the enthalpy-composition diagram gives a clear and exact picture of the effect of operating variables in distillation problems. Its only apparent disadvantage as compared with other graphical methods is that in some cases it requires larger graph paper.

BIBLIOGRAPHY

[1] Baker, E. M., and Lindsay, R. A., Ind. Eng. Chem. 35, 418 (1943).
[2] Dodge, B. F., Chemical Engineering Thermodynamics, 1st ed. McGraw-Hill Book Co. (1944).
[3] Ponchon, P., Tech. Moderne, 13, 20 (1921).
[4] Randall, M., and Longtin, B., Ind. Eng. Chem. 30, 1063, 1188 (1938).
[5] Robinson, C. S., and Gilliland, E. R., Elements of Fractional Distillation, 3rd ed. McGraw-Hill Book Co. (1939).

Measurement of Flow of Fluids Through Orifice Meters

With Particular Reference to the Measurement of Liquids and Steam

WM. L. COWAN
Union Oil Company of California

FLUID being measured should be of relatively constant composition.

Characteristics of fluid being measured must be known so that its density can be accurately determined for various flow conditions.

For accurate liquid measurement the pressure of the liquid should be high enough to prevent vaporization of liquid or other dissolved gases.

For steam or gas measurement the meter run and flow lines should be free from liquid accumulations.

Flow for good measurement should be such that the pressure and differential record can be clearly read. Where flow is extremely variable, it can only be recorded by spreading out the flow records by use of charts revolving at shorter periods than commonly used.

Differential and pressure recordings, when possible, should be of such magnitude that they will be registered from 5 to 10 units on a square-root chart or the equivalent of these square-root-chart readings when other forms of charts are used. Changes in orifice size or of the ranges of pressure spring or differential gauge offer means of adjusting the position of these records on the recording chart.

Flow should be in turbulent-flow region for good measurement.

Sufficient lengths of straight pipe both upstream and downstream from the orifice plate must be installed to prevent any distortion of flow both at the orifice plate and at the pressure taps. The lengths of straight pipe required varies with the orifice to pipe ratio, β, the lengths of straight pipe required increasing as the value of this ratio increases. Orifice-meter installations should, however, be designed so that correct measurement can be obtained with any orifice which may be used. The lengths of straight pipe used should therefore be designed for the maximum allowable orifice to pipe diameter ratio. Specifications for the minimum lengths of these meter runs based on the use of the maximum allowable orifice to pipe

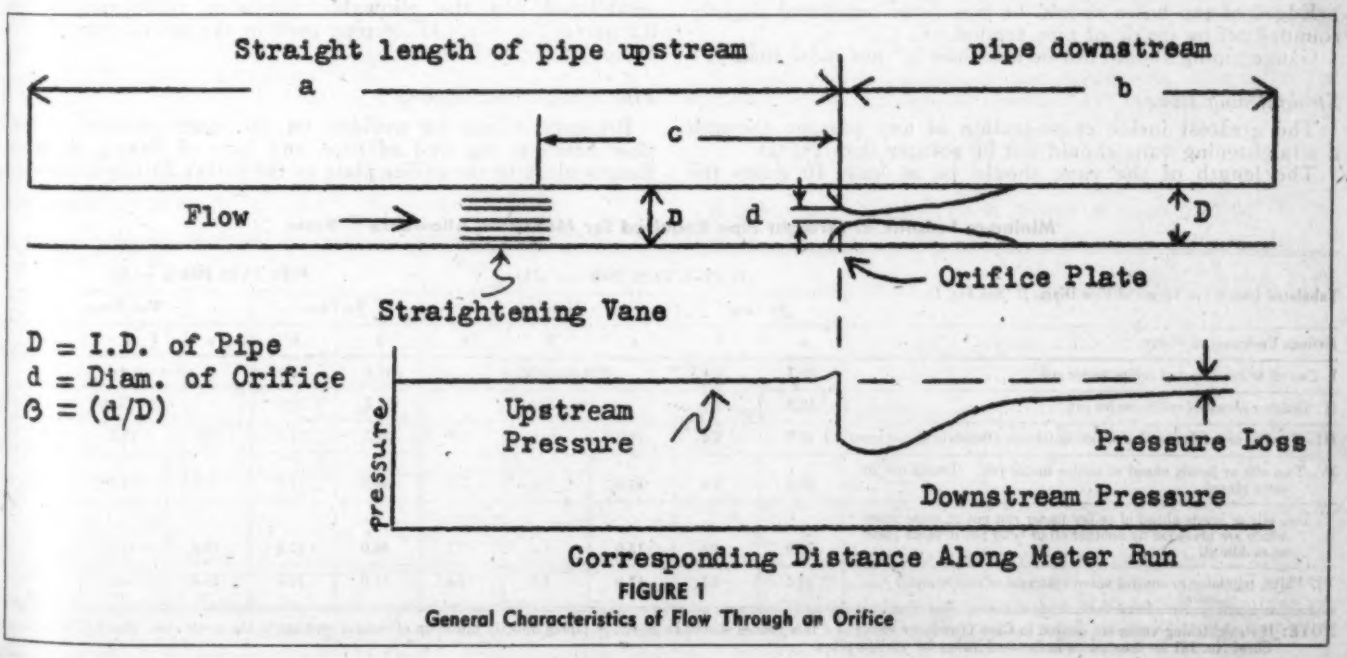


FIGURE 1
General Characteristics of Flow Through an Orifice

diameter ratio as well as other general orifice-meter installation specifications are furnished below.

Flange taps are recommended in all instances and particularly in the measurement of fluids through vertical meter runs.

In the measurement of fluids no pulsation of fluid at the orifice meter should be present. It is generally impossible to accurately measure fluids by an orifice meter when pulsation is present.

In the handling of gases or steam the most satisfactory method of suppressing pulsation at the orifice meter is to introduce a large reservoir or a pressure drop or a combination of both between the orifice meter and the source of pulsation. No general rule has yet been devised to cover the volume of the reservoir or pressure drop needed to suppress pulsation in any given situation. In some instances errors in measurement caused by pulsation can be minimized by the use of a meter run which will permit the use of a high β ratio orifice and the carrying of a high differential pressure. By locating orifice meters at a considerable distance from the source of pulsation, the volume of the pipe and the resistance to flow through the pipe are utilized to suppress pulsation.

In the case of liquids, the use of surge chambers or pressure drop or both between the source of pulsation and the meter are recommended for suppression of pulsation.

Orifice Meter Installation Specifications

Pressure Taps and Allowable β Ratios

Let l_1 = distance from upstream tap to downstream face of orifice plate.

Let l_2 = distance from downstream tap to downstream face of orifice plate.

Tap System	l_1	l_2	Range of β Recommended	Range of β Allowable
Flange Taps	1″	1″	.15 to .70	.10 to .75
Pipe Taps	(2½)D	8D	.20 to .67	.15 to .70
Throat Taps	1D	(½)D	Coefficients not	
Corner Taps	0	0	Standardized	

Specifications for Diam. of Pressure Tap Openings at Inside of Pipe

Openings should not be less than ¼″ in any case.

Openings for 2″ to 4″ pipe should not be greater than (⅛)D.

Openings for 4″ to 8″ pipe should not be greater than ½″.

Openings for 8″ and larger pipe should not be greater than (1/16)D.

Edges of tap holes should be free from burrs and slightly rounded off on inside of pipe section.

Gauge piping should not be less than ¼″ nor more than ¾″.

Straightening Vanes

The greatest inside cross-section of any passage through a straightening vane should not be greater than (¼)D.

The length of the vane should be at least 10 times the greatest inside cross-section of any passage through the vane. Vanes should be firmly constructed and securely fastened in place.

Allowable Tolerances in I.D. of Pipe Used for Orifice Meter Runs from the I.D. of Pipe Used in the Computation of the Orifice Meter Coefficient, Based on the Use of an Orifice Having the Maximum Allowable β Ratio.

Type of Orifice Fitting Used	FLANGE TAPS		PIPE TAPS	
	Up-stream	Down-stream	Up-stream	Down-stream
When using plain flange orifice fittings	0.50% D	1.00% D	0.2% D	0.4% D
When using Robinson, Daniel or commercial types of orifice fittings	0.25% D	0.50% D	0.2% D	0.4% D

Note: I.D. of pipe should be determined at cross sections of 1″ from face of flange and at other cross sections up to one pipe diameter from face of flange. Measurements of I.D. of pipe should be taken over three and preferably five or six diameters. The difference between the maximum and minimum observed diameters (i.e. the out of roundness) should not exceed the tolerence specified above.

Thermometer Wells and Sampling Connections

Thermometer wells and sampling connections should be placed downstream from orifice at least not closer than "minimum downstream specified straight length of pipe." If straightening vanes are used, the thermometer well or sampling connection can be installed in the upstream meter run one pipe diameter or more upstream of straightening vane. Thermometer wells should be inserted in such a manner that true flow temperature is obtained. Sampling connections should be of center-line type.

In measurement of moist steam, sampling devices should be installed for determining steam quality if accurate measurement is required.

The sections of pipe used for meter tubes, that is the pipe sections adjacent to the orifice flange or orifice fitting shall be as nearly cylindrical, smooth and free from blisters and scale as can be commercially obtained. The method of determining the I.D. of the pipe and also the allowable tolerance between the actual I.D. of the pipe and the I.D. of the pipe used in the computation of orifice meter coefficients are given above.

Pipes having the following scheduled (published) I.D. have been chosen as standard for use in orifice meter runs: 2.067″, 3.068″, 4.026″, 6.065″, 8.071″, 10.19″, 12.09″, 15.25″, and 19.18″. Orifice meter coefficients have been established for such pipe, based on these diameters. Pipes of other scheduled I.D. may, however, be used and coefficients can be established for orifices used in such pipe. In some cases, the actual I.D. of the upstream pipe section is used in the calculation of coefficients, and in such instances this average diameter shall be obtained from the averages of measurements of the I.D. as above specified.

The allowable tolerance in the bore of orifice fittings of the Robinson, Daniel, etc., types have not been definitely established but the allowable tolerance recommended is 0.2 percent of the I.D. of pipe used in the calculation of the orifice meter coefficients.

Pipe Flanges and Gaskets

Recesses should be avoided on the inner surface of the pipe between the end of pipe and face of flange on pipe flanges close to the orifice plate or the orifice fitting, however,

Minimum Lengths of Straight Pipe Required for Maximum Allowable β Ratio

Tabulated Lengths in Terms of Pipe Diam. D (See Fig. 1)	FLANGE TAPS FOR β = .75					PIPE TAPS FOR β = .70				
	No Vane		With Vane			No Vane		With Vane		
Fittings Upstream of Meter	a	b	a	b	c	a	b	a	b	c
I. One ell or tee ahead of orifice meter run	16.7	4.4	(Not required)			16.0	12.3	(Not required)		
II. Reducer ahead of orifice meter run	13.7	4.4	(See Note)			14.3	12.3	(See Note)		
III. Two ells or bends ahead of orifice meter run. (Bends in same plane)	22.0	4.4	14.0	4.4	7.3	21.0	12.3	14.1	12.3	8.7
IV. Two ells or bends ahead of orifice meter run. (Bends not in same plane)	35.0	4.4	15.0	4.4	7.3	33.0	12.3	15.5	12.3	8.7
V. Two ells or bends ahead of orifice meter run not in same plane which are preceded by another ell or bend not in same plane as middle ell	70.0	4.4	15.0	4.4	7.3	66.0	12.3	15.5	12.3	8.7
VI. Valve, regulator or control valve upstream of orifice meter run	44.5	4.4	17.0	4.4	7.3	41.0	12.3	17.4	12.3	8.7

NOTE: If straightening vanes are desired in Case II reducer ahead of orifice, vanes should be placed in piping directly upstream of reducer and not in the meter run. (See S.C.M.A. Data Sheet No. 181 for dimensions in feet and inches for various pipes.

a recess ¼-inch long as measured parallel to the axis of the pipe is allowable.

Pipe flange and orifice fitting flange and gasket should be dowelled in such a manner that I.D. of pipe is centered to I.D. of orifice fitting and so that the gasket will not protrude into the bore of the pipe. The I.D. of the gasket should be slightly larger than I.D. of pipe.

Orifice Plate Specifications

Orifice Plate Specifications Pipe Sizes	Allowable Plate Thickness
2″ up to 4″ pipe.	Not less than 1/16″ nor greater than ⅛″.
4″ up to 16″ pipe	Not less than ⅛″ nor greater than ¼″.
16″ and larger pipe.	May exceed ¼″ but not greater than ⅜″.

Thickness of Orifice Plate at Orifice Edge

The thickness of the orifice plate at the edge of the orifice shall not exceed (1/30)D, and preferably (1/50)D, or (1/8)d, or (1/8) (D-d), the minimum of the above requirements governing in all cases. Beveling of the orifice plate at the orifice with a 45-degree bevel on the downstream side is often required to fulfill the above specifications for orifice plates. (See S.C.M.A. Data Sheet No. 188.)

Orifice plates should not deviate from flatness more than 0.01″ per inch of pipe radius and plate must be placed perpendicular to axis of pipe.

The upstream edge of an orifice shall be square and sharp and not appreciably reflect a beam of light when viewed without magnification and face of plate should be kept clean at all times.

General Derivation of Orifice Meter Flow Formulas

The energy of a fluid at any point in a pipe line can be expressed in feet head of fluid at flowing density, which head is a combination of Head of Postion H_e, Pressure Head H_p, and Velocity Head H_v. The meanings of these heads is illustrated below.

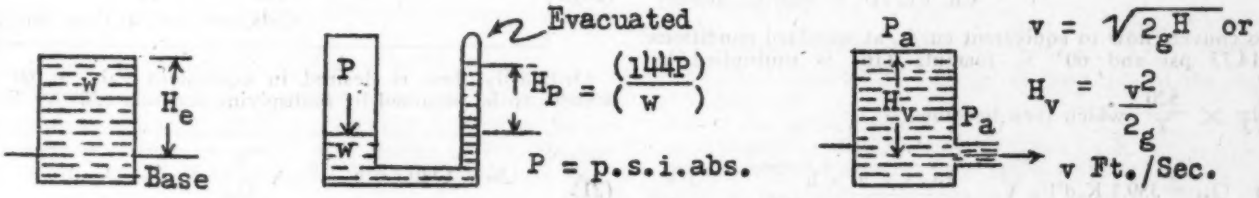


FIGURE 2

Considering then the flow of any fluid through an orifice in a pipe line and considering a horizontal meter run, the derivation of flow formula is as follows: (See Figure 3.)

General Fluid Flow Formulas

	I	II
Velocity in Ft./Sec.	v_1	v_2
Pressure Psi Abs.	P_1	P_2
Density Fluid Lbs./Cu. Ft.	w	w
Cross-section Area, Sq. Ft.	A_1	A_2

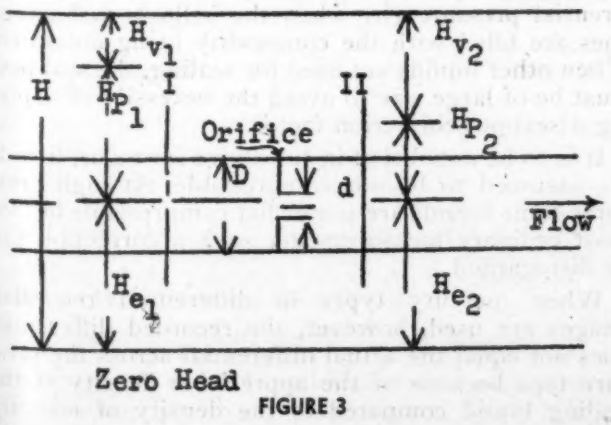


FIGURE 3

(1) $A_1 = \frac{\Pi}{4}\left(\frac{D}{12}\right)^2$ $A_2 = \frac{\Pi}{4}\left(\frac{d}{12}\right)^2$

(2) Flow Cu. Ft. Sec. A_1v_1 A_2v_2

(3) $v_1 = \frac{A_2v_2}{A_1} = \left(\frac{d}{D}\right)^2$ $v_2 = \beta^2 v_2$

Assuming no loss in energy from I to II then

(4) $H_{e1} + H_{P1} + H_{v1} = H_{e2} + H_{P2} + H_{v2}$ but since $H_{e1} = H_{e2}$ for horizontal run

(5) $\frac{144P_1}{w} + \frac{v_1^2}{2_g} = \frac{144P_2}{w} + \frac{v_2^2}{2_g}$ and substituting for v_1 from (3)

(6) $\frac{144P_1}{w} + \frac{\beta^4 v_2^2}{2_g} = \frac{144P_2}{w} + \frac{v_2^2}{2_g}$

(7) $\frac{144}{w}(P_1 - P_2) = \frac{v_2^2}{2_g}(1 - \beta^4)$ and solving for v_2

(8) $v_2 = \sqrt{\frac{144(P_1 - P_2)}{w} \times \frac{2_g}{(1-\beta^4)}}$ Ft./Sec.

Inserting a test coefficient of discharge (c) to convert theoretical flow to actual flow in the formula $Q_a = A_2v_2$ then

(9) $Q_{sec} = c \times \frac{\Pi}{4}\left(\frac{d}{12}\right)^2 \times \sqrt{\frac{144(P_1 - P_2)2_g}{w(1-\beta^4)}}$ Cu. Ft. Sec.

The velocity of approach factor $(1/\sqrt{1-\beta^4})$ can be combined with (c) into a coefficient of discharge $E = (c/\sqrt{1-\beta^4})$ and showing the differential pressure in feet of flowing fluid $H = \left(\frac{144(P_1 - P_2}{w}\right)$, and multiplying by 3600 the flow formula can be shown as

(10) $Q_f = \frac{\Pi}{4}\frac{d^2}{144} \times \left(\frac{c}{\sqrt{1-\beta^4}}\right) \times \sqrt{2_g H} \times 3600 =$ $19.64\, d^2 E \sqrt{2_g H}$ Cu. Ft./Hr.

A more useful formula is one expressing differential by $P_1 - P_2$ and by multiplying equation (9) by 3600

(11) $Q_f = 1890.0\, d^2 E \sqrt{\frac{P_1 - P_2}{w}}$ Cu. Ft./Hr.

If differential is recorded in inches of water h at 60° F. instead of $(P_1 - P_2)$ where

1″ Water Pressure $= \frac{h}{12} \times \frac{62.37}{144} = .036094$ psi, then (11) becomes

$Q_f = 1890.0\, d^2 E \sqrt{\frac{.036094\, h}{w}}$ or

(12) $\boxed{Q_f = 359.1\, d^2 E \sqrt{h/w}}$ Cu. Ft./Hr. at flow density or

(12)′ $\boxed{W = 359.1\, d^2 E \sqrt{hw}}$ Lbs. per hour as $W = Q_f \times w$

For any one set of pressure taps, the coefficient E for any one pipe size has a definite value for any given sized orifice when the value of R (The Reynolds Number at the plane of the orifice) is infinite. This value of E is called K_e. For any

other value of R the value of E also has a definite value for this same orifice and pipe; the ratio of this actual value of E to its value K_o being called the Reynolds No. factor (F_R), where $F_R = E/K_o$, therefore,

(13) $E = K_o F_R$ and formula (12) becomes equal to

(14) $\boxed{Q_f = 359.1\ d^2 K_o F_R \sqrt{h/w}}$ Cu. Ft./Hr. at flow density

Notes on K_o

In C.N.G.A. Bulletin TS-353 tables of $Z = 338.2\ K_{o1}$ are given for each .001 change in β where $K_{o1} = K_o$ for a 4.026" I.D. pipe. Other tables of (L) values are given for other standard pipe sizes for each .01 change in β. For any one orifice in any one pipe, the value of K_o for Flange Taps are different from those for Pipe Taps.

Where $L = \frac{K_o \text{ for other pipe}}{K_{o1} \text{ for 4.026" pipe}}$ or $K_o = LK_{o1}$ for other pipe.

Flow Equations for Gases

Referring to formula (14) the density of the gas is equal to

(15) $w = \frac{.07654\ GPY \times 520}{14.73 \times T}$ Lbs./Cu. Ft., where

Density of air at 14.73 psi abs. and 60° F. or 520° abs. = .07654 lbs./cu. ft.

G = Ratio of weight of a cubic foot of gas to a cubic foot of air at 14.73 psi and 60° F.

P in the following formulas will represent some intermediate pressure between P_1 and P_2 which when used in formula (15) gives true gas density.

Y is the supercompressibility factor for the gas.

Substituting this value of w in equation (14),

(16) $Q_f = 359.1\ K_o d^2 F_R \sqrt{\frac{14.73 \times T\,h}{.07654\ GPY \times 520}}$ or

(16)′ $Q_f = 218.44\ K_o d^2 F_R \sqrt{\frac{hT}{GPY}}$ Cu. Ft./Hr. at flowing density

To convert flow to equivalent cu. ft. at standard conditions of 14.73 psi and 60° F. formula (16) is multiplied by $\frac{PY}{14.73} \times \frac{520}{T}$ which then becomes

(17) $Q_{st} = 359.1\ K_o d^2 F_R \sqrt{\frac{14.73 \times T \times h}{.07654 \times GPY \times 520}} \times \frac{PY}{14.73} \times \frac{520}{T}$ Std. Cu. Ft. at 14.73 psi and 60° F.

In actual practice the downstream pressure P_2 is usually recorded in place of the intermediate pressure P used above and consequently when P_2 is inserted in (17) a correction factor F_{pv} known as the expansion factor must be applied, which factor varies with β ratio and ratio of h/P_2. Using P_2 in place of P flow then becomes equal to

(18) $Q_{st} = (338.2\ K_o d^2) \times F_{pv} \times F_R \times \sqrt{1/G} \times \sqrt{520/T} \times \sqrt{Y} \times \sqrt{hP_2} =$ Std. Cu. Ft.

$= \frac{\text{(Basic Hourly)}}{\text{(Coef)}} \times \frac{\text{(Exp.)}}{\text{(Fact)}} \times \frac{\text{(Rey.)}}{\text{(Fact)}} \times \frac{\text{(Grav.)}}{\text{(Fact)}} \times \frac{\text{(Temp.)}}{\text{(Fact.)}} \times \frac{\text{(Sup. Exp.)}}{\text{(Fact.)}} \times \text{Ext.}) = \text{Std. Cu. Ft.}$

$= C \times F_{pv} \times F_R \times F_G \times F_T \times F_{PV} \times \sqrt{hP_2} =$ Std. Cu. Ft.

(18)′ $Q_{st} = C\ F_{pv}\ F_R\ F_G\ F_T\ F_{PV} \sqrt{hP_2}$ Standard Cu. Ft. at 14.73 psi abs and 60° F.

Note: When gases are measured at extremely high pressures or when some type of liquid sealing fluids are used special seal factors are required. See Formula 23. When liquid seals are used on gas meters an additional seal factor F_s, which equals $\sqrt{1 - G_s/13.56}$, must be applied to the general flow formula, where G_s is the specific gravity of the sealing liquid referred to a base of water at 60° F. = 1.0000.

When no liquid sealing is used in the measurement of gases over 500 psi gauge, the density of gas compared to the density of mercury becomes appreciable. Let G = the specific gravity of the gas compared to air = 1.0000 as previously defined and let G_a = ratio of the weight of one cubic foot of gas at flowing pressure and instrument temperature to the weight of one cubic foot of water at 60° F. The additional factor F_a as shown by formula (23) should be used in the measurements of gases at pressures over 500 psi gauge. A simplified formula for the computation of this value of F_a for gases as shown below.

$G_a = \frac{(.07654 \times GPY \times 520)}{(14.73\ T \times 62.37)} = \left(.04332\ \frac{GPY}{T}\right)$ and

$F_a = \sqrt{1 - .003195\ \frac{GPY}{T}}$

Example for P = 715# G = .7 and Y = 1.17 and T = 520° Fabs., F_a = .9982

Flow Equations for Liquids

Let G_{60} = Spec. gravity of liquid at 60° F., which equals the ratio of its density at 60° F. to weight of an equal volume of water at 60° F.

Let G_f = Spec. gravity of liquid at flowing temperature conditions which equals the ratio of its density at flowing temperature to the density of an equal volume of water at 60° F.

Actual density of a liquid at flowing temperature in Lbs./Cu. Ft. equals

(19) $w = 62.37 \times G_f$ or $w = 62.37\ G_{60} T_c$ where $T_c = \frac{G_f}{G_{60}} = \frac{w}{w_{60}}$ The value of T_c is available for most all common liquids in published tables.

Substituting the value of $w = 62.37\ G_{60} T_c$ and multiplying by 7.481 the number of gals. per cu. ft. equation for liquid flow becomes

$Q_f = 359.1\ d^2 K_o \times F_R \sqrt{\frac{h}{62.37\ G_{60} T_c}} \times 7.481$

(20) $\boxed{Q_f = (340.1\ d^2 K_o)\ F_R \sqrt{\frac{1}{G_{60}}} \times \sqrt{\frac{1}{T_c}} \sqrt{h}}$ Gals. per hour at flow density

Ordinarily flow is desired in equivalent gals. at 60° F. which can be obtained by multiplying formula (20) by T_c or,

(21) $\boxed{Q_{60} = (340.1\ d^2 K_o)\ F_R \sqrt{\frac{1}{G_{60}}} \sqrt{T_c} \sqrt{h}}$ Gals. per hour at 60° F.

If flow is desired in lbs./hr. = $Q_f w = Q_f G_{60} T_c \times 62.37$

$w = (359.1\ d^2 K_o)\ F_R \sqrt{h/w} \times w = 359.1\ d^2 K_o\ F_R \sqrt{hw}$

$w = (359.1\ d^2 K_o)\ F_R \sqrt{h \times 62.37 \times G_{60} T_c}$

(22) $\boxed{w = 2836.\ d^2 K_o\ F_R \sqrt{h G_{60} T_c}}$ lbs./hr.

In the above formulas 20, 21, 22, (h) is the actual differential pressure across the pressure taps. Bellows types of differential recorders, record this true differential pressure (h) when the bellows and gauge lines are filled with the commodity being measured. When other liquids are used for sealing, the seal pots must be of large size to avoid the necessity of applying a seal-pot-correction factor.

It is to be noted that in the above formulas, liquids are assumed to be non-compressible. At high pressures some liquids are somewhat compressible but for most ordinary measurements such a correction can be disregarded.

When mercury types of differential recording gauges are used, however, the recorded differential does not equal the actual differential across the pressure taps because of the appreciable density of the sealing liquid compared to the density of mercury

referring to Figure 4 the correction factor required is determined as follows:

The true differential head $= P_1 - P_2$

Expressing P_1 and P_2 in inches of mercury

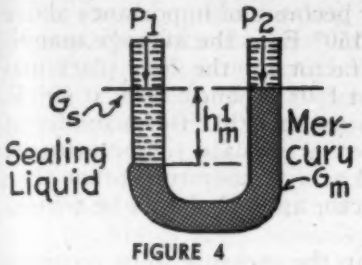


FIGURE 4

$$P_1 + h'_m \frac{G_s}{G_m} = P_2 + h'_m \qquad \text{Or } P_1 - P_2 = h'_m \left(1 - \frac{G_s}{G_m}\right)$$

where,

G_s = Specific gravity of sealing liquid compared to water at 60° F. = 1.0000.

G_m = Specific gravity of mercury liquid compared to water at 60° F. = 1.0000. By multiplying both sides of the above equation by G_m, pressures are converted to inches of water and the equation becomes,

$(P_1 - P_2)\, G_m = h'_m G_m (1 - G_s/G_m)$

where, $(P_1 - P_2)\, G_m = h$ = true differential pressure in inches of water

$(h'_m G_m) = h'$ = recorded differential pressure in inches of water

therefore, $h = h'(1 - G_s/G_m)$

In orifice meter flow calculations, it is necessary to solve for $\sqrt{h}$. The above formula for h can then be rewritten as follows:

$\sqrt{h} = \sqrt{h'}\ \sqrt{1 - G_s/G_m}$ and since h' is the recorded differential when mercury type differential gauges are used, an additional correction factor F_s, commonly called the seal factor, is required when mercury differential gauges are used, where

(23) $\quad F_s = \sqrt{1 - G_s/G_m} = \sqrt{(G_m - G_s)/G_m}$

In formula (23) it is assumed that seal pots are of large enough size so that the sealing-liquid levels in each seal pot remain practically unchanged between zero to maximum flow rates. (See special F_s formulas when this is not the case.) In the above equations G_s and G_m are the specific gravities of the sealing liquid and mercury at gauge temperature. Usually gauge temperature is assumed as being at 60° F. and the error involved by this assumption is ordinarily small. G_m at 60° F. = 13.56. For a gauge at 100° F., for example, the maximum possible error caused by this assumption is about 1/10 of 1 percent, the degree of error varying with the type of liquid over the mercury. Where no specific sealing liquid is used, the metered liquid is the sealing liquid.

Formulas (20), (21), and (22) can then be written for the liquid flow using mercury type differential recorders as follows:

(20)′ $Q_f = (340.1\, d^2 K_o) F_R F_s \sqrt{1/G_{60}} \times \sqrt{1/T_f}\ \sqrt{h'}$ Gals./Hr. at flow density

(21)′ $Q_{60} = (340.1\, d^2 K_o) F_R F_s \sqrt{1/G_{60}} \times \sqrt{T_f}\ \sqrt{h'}$ Gals./Hr. at 60° F.

(22)′ $W = (2836.\, d^2 K_o) F_R F_s \sqrt{h' G_{60} T_f}$ Lbs./Hr.

For liquids, values of $(340.1\, K_o d^2)$ and $(2836.\, K_o d^2)$ can be obtained from published tables for gases of $C = 338.2\, K_o d^2$ by multiplying these published values of $C = 338.2\, K_o d^2$ for gases, by (340.1/338.2) and (2836./338.2).

If G_f, the actual flowing specific gravity is known

In formulas (20) and (20)′, $\sqrt{1/G_f}$ can be used in place of $\sqrt{1/G_{60} T_f}$

In formulas (21) and (21)′, $T_f \sqrt{1/G_f}$ can be used in place of $\sqrt{T_f/G_{60}}$

In formulas (22) and (22)′, $\sqrt{G_f}$ can be used in place of $\sqrt{G_{60} T_f}$

Values of $\sqrt{1/G_{60}}$, $\sqrt{1 - G_s/G_m}$, $\sqrt{T_f}$ and $\sqrt{1/T_f}$ can be obtained for a number of petroleum products and for water from S.C.M.A. data sheets No. 147 to No. 152 inclusive.

Approximate Values of Reynolds No. Factor F_R (Flange Taps) for Values of (R)

β	100	200	400	600	800	1000	2000	3000	4000	6000	10000	20000	50000	100000
.2	1.150	1.157	1.148	1.135	1.120	1.102	1.072	1.059	1.052	1.043	1.036	1.026	1.017	1.008
.3	1.152	1.165	1.155	1.140	1.124	1.110	1.077	1.062	1.055	1.045	1.037	1.026	1.017	1.008
.4	1.154	1.174	1.165	1.153	1.138	1.125	1.095	1.080	1.070	1.056	1.045	1.030	1.017	1.008
.5	1.160	1.195	1.198	1.187	1.175	1.161	1.122	1.100	1.087	1.070	1.052	1.036	1.017	1.008
.55	1.175	1.213	1.223	1.213	1.200	1.190	1.148	1.122	1.100	1.080	1.055	1.036	1.017	1.008
.6	1.196	1.240	1.252	1.247	1.237	1.226	1.177	1.143	1.118	1.090	1.060	1.037	1.017	1.008

R, the Reynolds No. at plane of orifice can be determined if flow is known.

(24) If Q = Gals./Hr. at 60° F. $\quad R = (.0354\, Q G_{60})/(d\, u)$

(24)′ If Q = Bbls./Hr. at 60° F. $\quad R = (1.486\, Q G_{60})/(d\, u)$

Where d = orifice diam. in inches and u = viscosity in lbs./sec. ft. at flow temp.

In the above table of F_R values it is assumed that the F_R value will be the same for all pipe sizes for any given Reynold's No. for a given orifice to pipe ratio β. Tests indicate that this assumption is reasonably correct. If, however, greater accuracy is desired in the measurement of liquids of lower viscosity having flow rates giving Reynold's No. above 50,000 the F_R value can be computed from the formula given in C.N.G.A. Bulletin TS-353 as follows:

$$F_R = 1 + \frac{(J + B)d}{R}$$

d = orifice diam. in inches and D = pipe diam. in inches

$J = 830. - 5000.\,\beta + 9000\beta^2 - 4200\beta^3$ for Flange and Pipe Taps

$B = 530/\sqrt{D}$ for Flange Taps

$B = 75 + (875/D)$ for Pipe Taps

R = Reynolds' No. at plane of orifice $= \frac{vdw}{12u}$, where

v = actual velocity of fluid jet at the plane of the orifice, ft. per sec.

d = orifice meter, inches

w = density of fluid at orifice, lbs. per cu. ft.

u = viscosity of flowing fluid, lbs. per sec. ft.

Viscosity Units and Conversions

1 Centipoise = viscosity of water at 68° F. = .000672 lbs./sec. ft.

1 Poise = 100 centipoises = .0672 lbs./sec. ft.

S = Saybolt Seconds Universal $= G_{60} T_f \left(.0022\, S - \frac{1.8}{S}\right)$ .0672 lbs./sec. ft.

S = Saybolt Seconds Universal $= G_{60} T_f \left(.0022\, S - \frac{1.8}{S}\right)$ Poises

Flow Formulas for Steam

If the density of steam is determined from the pressure at the downstream pressure tap, the general flow formula can be obtained from formula (12)′ and inserting the F_{e2} factor so that,

(25) $\quad W = (359.1\, d^2 K_o)\, F_{e2} F_R \sqrt{hw}$ Lbs./Hr.

As F_{e2} and F_R are relatively small, these factors are usually omitted particularly in measurement of steam at high pressures. The values of F_{e2} and F_R given in C.N.G.A. Bulletins TS-353 and TS-402 for gas can be assumed to be approximately the same as for steam if it is found desirable to use them.

The density of steam can be determined directly from steam tables if the steam pressure, degrees of superheat or quality are known.

Density of steam of 100 percent quality can be

obtained directly from steam tables if its pressure is known.

Density of wet steam can be found if the pressure and quality are known. Letting w_s = density saturated steam, then density of wet steam of quality (X) equals

(26) $w = \frac{w_s}{X}$ or $X = \frac{w_s}{w}$ or $wX = w_s$

Note the quality of steam can be determined by steam calorimeter.

Density of superheated steam can be determined from steam tables if its pressure and temperature are known.

In many instances the pressure in steam measurements and steam quality or degrees superheat are relatively constant so that flowing density can be incorporated in the general coefficient and flow then equals this coefficient $x\sqrt{h}$ giving flow in pounds per hour.

Bellows types of differential gauges record the actual differential head (h) so that when these types of gauges are used the above formula (25) can be used as shown.

When mercury type recorders are used, an additional correction for the water over the mercury is required as in all steam measurements water seal pots are used and F_s from (23) =

(27) $F_s = \sqrt{1 - (1/13.56)} = .9625$

For mercury recorders, therefore, this value of F_s can be incorporated in the general flow equation which becomes

(28) $W = (345.6\ K_o d^2)\ F_{ec} F_R \sqrt{h'w}$ lbs./hr.

A more general method of computation is to set up a set of coefficients based on the density of saturated steam at 114.4 psi abs. which equals .2564 lbs./cu. ft. and compute $\sqrt{w}$ from pressure records and the quality or superheat of steam.

For mercury type recorders, coefficients have been established which first assume that the density of steam varies directly with the ratio of $\left(\frac{.2564 \times P_s}{114.4}\right)$ and then additional factors F_P and (F_x or F_s) established to correct for this assumption, formula (28) can then be written for mercury recorders as follows:

$$W = (345.6\ K_o d^2) \sqrt{\frac{.2564\ P_s}{114.4}} \times F_P \times (F_x \text{ or } F_{su}) \times F_{ec} F_R \sqrt{h'} \text{ lbs./hr.}$$

(29) $$\boxed{W = (16.36\ K_o d^2)\ F_P (F_x \text{ or } F_{su}) F_{ec} F_R \sqrt{h' P_s}} \text{ lbs./hr.}$$

(30) Where $F_P = \sqrt{\frac{w_s \times 114.4}{.2564\ P_s}}$
where w_s = actual density of saturated steam at P_s

(31) Where $F_x = \sqrt{w/w_s}$
where w = actual density of wet steam of quality (x) at pressure P_s

$= \sqrt{\frac{1}{x}}$ x = steam quality

(32) Where $F_{su} = \sqrt{w/w_s}$
where w = actual density of superheated steam at P_s

When bellows type differential gauges are used, the flow can be obtained by multiplying above mercury gauge formulas by factor (1/.9625) = 1.039.

As steam usually is measured at a high temperature, the orifice plate expands to a small degree and the diameter of the orifice is slightly enlarged from its value at atmospheric temperature. This condition may also exist when measuring any other fluid at a high temperature. Correction factors for plates of various materials are given for this effect in meter manuals. These published factors represent the ratio of (d^2, at flowing temperature)/(d^2 at 60° F.). The application of this factor becomes of importance above flowing temperature of 150° F. as the average magnitude of this correction factor for the four plate materials shown is 1.0016 at 150° F., and 1.0000 at 60° F. These published factors assume that the diameter of the orifice was measured at a plate temperature of 60° F. If it is measured at a temperature other than 60° F., the correction factor applied should be revised accordingly.

In steam measurement, the pressure to be recorded is the pressure of steam on the steam line at P_2. If a test gauge is placed at the recorder the indicated pressure must be corrected for the head of water between the steam pots and the recorder, 1 foot of water head equalling .433 psi.

Values of 16.36 $K_o d^2$, 345.6 $K_o d^2$ and 359.1 $K_o d^2$ can be obtained from published tables of C = 338.2 $K_o d^2$ for gases by multiplying these published values of C = 338.2 $K_o d^2$ for gases, by (16.36/338.2), (345.6/338.2) and also obtainable from revised S.C.M.A. data sheets 159 and 160. Values of F_P, F_x, and F_{su} are given on S.C.M.A. data sheet 162.

Special Orifice Sizes for Given Flow Conditions

Gas Flow (F_s omitted, see Formula (18'))

(50) $Q = (338.2\ K_o d^2)\ F_{ec} F_R F_G F_T F_{PV} \sqrt{h P_2}$ Std. Cu. Ft./Hr.

(51) $K_o d^2 = K_o \beta^2 D^2$ and $K_o = K_{o4} L$ also $K_{o4} = Z/338.2$
The above general gas formula can then be written.

(52) $K_o \beta^2 = Q/(338.2\ D^2 F_{ec} F_R F_T F_{PV} F_G \sqrt{h P_2})$ or

(53) $K_{o4} \beta^2 = Q/(338.2\ LD^2 F_{ec} F_R F_T F_{PV} F_G \sqrt{h P_2})$ or

(55) $338.2\ K_{o4} \beta^2 = Q/(D^2 L F_{ec} F_R F_T F_{PV} F_G \sqrt{h P_2} = Z\beta^2$

Curves or tables of $K_o \beta^2$ versus β, or $K_{o4} \beta^2$ versus β or $Z\beta^2$ versus β can be made. For a given specified flow condition and differential, quick approximations of orifice size required can be obtained from relation

(55) $338.2\ K_o d^2 = C = Q/(F_G F_T F_{PV} \sqrt{hP})$ and nearest (d) determined from tables of C for standard sized orifices and pipes. Correction factors $LF_e F_R$ can then be quite accurately determined for this approximate orifice and used in the above equations.

By solving for $K_o \beta^2$, $K_{o4} \beta^2$ or $Z\beta^2$, the value of β can be obtained directly from tables or curves used. (See formulas 52, 53, 54.)

(56) Knowing β, orifice diameter $d = \beta D$

Liquid Flow

(57) $Q = (340.1\ K_o d^2) F_S F_G F_T F_R \sqrt{h'}$ Gals. per hr. at 60° F., (mercury gauge)

(57)' = $(338.2\ K_o d^2) F_S F_G F_T F_R \sqrt{h'} \times (340.1/338.2)$ Gals. per hr. at 60° F.
Note: $F_G F_T$ are liquid gravity and temperature factors based on water = 1.000

(58) $K_o \beta^2 = Q/(340.1\ D^2 F_G F_T F_R F_S \sqrt{h'})$ or

(59) $K_{o4} \beta^2 = Q/(340.1\ LD^2 F_G F_T F_R F_S \sqrt{h'})$ or

(60) $Z\beta^2 = \frac{Q \times 338.2}{D^2 L F_G F_T F_R F_S \sqrt{h'} \times 340.1}$

Obtaining β from curves or tables, $d = \beta D$

Steam

(61) $W = 345.6\ K_o d^2\ F_e F_R \sqrt{wh'}$ lbs. per hr. (mercury gauge) or
$= 16.36\ K_o d^2\ F_e F_R F_P (F_x \text{ or } F_{su}) \times \sqrt{h' P_2}$ lbs. per hr. (mercury gauge)
Solving for $Z\beta^2$ and using the equation for density w

$Z\beta^2 = \frac{W \times 338.2}{D^2 L F_e F_R \sqrt{w} \times 345.6}$, obtain β from $Z\beta^2$ curves and solve for $d = \beta D$

Note: If values of $ZL\beta^2$ are plotted against β for each

standard pipe size, (L) would be omitted from equations. Such curves can, however, only be used in computing orifice for standard pipe sizes.

Special Sealing Liquids for Seal Pot Installations

The use of special sealing liquids at some point between the pressure taps on the flow line and the recording gauge is essential when metering the following fluids: Corrosive gases or liquids; liquids containing considerable quantities of entrained gases; gases containing considerable quantities of entrained liquids or gases which are readily condensible when cooled below flow-line temperature at flow-line pressure; liquids of high viscosity at atmospheric temperature; fluids which react with or cause emulsification of mercury when mercury recording gauges are used; liquids containing appreciable amounts of some other liquid which would tend to gradually separate out. In the measurement of steam, water (condensed steam), is always used as the sealing liquid.

Ordinarily water, light oil and gasoline measured at pressures high enough to prevent vaporization can be measured without using special sealing liquids. Such liquids are piped directly to and into the recording gauge. Small amounts of entrained vapors or other liquids can be trapped out and vented occasionally by use of special traps on gauge-line hookup.

The general specifications for a sealing liquid are that it be a liquid which will, (1) not mix with the flowing fluid or contaminate mercury when mercury gauges are used, (2) have a specific gravity different than that of flowing fluid, (3) be relatively non-viscous. In most instances water is the most commonly used sealing fluid as it is readily available, cheap and is usually entrained either in a liquid or vaporous state in most of the commonly measured fluids. Water is not desirable if freezing temperatures are expected. Other commonly used sealing fluids are various types of anti-freeze liquids containing anti-rust preventative which should only be used when flowing liquid has no entrained water as most of these liquids mix with water.

When sealing fluids are used, seal pots or reservoirs are required on both the upstream and downstream gauge piping. Both pots should be of the same size and so designed and installed that the level of the sealing fluid in each pot will be equal and remain practically equal from zero to maximum flow. If sealing levels are not held practically equal in poth pots, the seal factor given in formula (23) should be computed by special formulas shown later. Seal pots should be carefully leveled and firmly supported so that they will not cause a strain on gauge piping.

In measurement of liquids, gauge piping from pressure taps to seal pots (or to recorders when no seal pots are used) should be so installed that there is no possibility of entrapping air, gas or other entrained liquids.

In the measurement of gases containing free liquid and gases which tend to condense, gauge piping from pressure taps to seal pots (or to recorders if no seal pots used) should be so installed that any liquids formed will either drain back into the flow line or into special traps installed at low points of the gauge line. In measurement of such gases, pressure tap openings should take off at the top of or above the center of a horizontal meter run and slope upwards to seal pots (or to recorder if no seal pots are used). Pressure tap openings should be of maximum allowable size. Gate or plug valves on gauge lines are recommended. These same general recommendations also apply to the measurement of steam. For steam measurements, however, pressure tap openings should even be larger than the maximum specified size in order to allow condensed steam to drain back into the meter run. In one particular instance, see Figure 8, additional water drain lines for condensed water were found to be necessary when measuring an extremely varying flow of steam.

Recommended methods for installing seal pots and gauge piping, with reference to meter run and recording gauge, are shown on Figures 6 to 20, for various types of fluid measurements. The by-pass across the recording gauge may be either above or below the instrument.

The temperature gradient per foot of vertical height in gauge lines from pressure taps to seal pots (or to recorder when no seal pots are used) should be equal in both the upstream and downstream gauge lines. This is particularly a necessary precaution in case pipe taps are used. Flange taps are, however, recommended in every instance. In measurement of hot liquids which may congeal at lower temperatures, it may become necessary to add additional heat to this section of gauge piping and even to the seal pots in order to obtain a reliable differential record.

In the measurement of steam, water is always used as a sealing liquid. The size of the pots need not ordinarily be as large as those required in other fluid measurements as the sealing fluid levels in each pot are maintained by the condensation of the steam. Each pot should, however, have a liquid capacity at least double that of the maximum displacement of mercury in each side of the recording gauge. In the measurement of rapidly changing steam flow, however, large pots are recommended. In the measurement of superheated steam, the pots should be equipped with radiating fins or auxiliary finned cooling surfaces installed above the sealing pot. Air or other entrained gases may at times collect at the tops of steam-gauge piping and additional air traps installed at this point may become necessary. Gauge piping from water pots to pressure taps as well as pressure tap openings into flow line often plug up and prevent drainage of water back into flow line. These openings and this section of piping should be inspected occasionally and if meter is sluggish this is often the cause of the trouble.

In order to obtain the greatest available benefit from a cylindrical sealing pot, the pots should be installed in the horizontal position as this position provides a greater sealing liquid surface per size of pot. Vertically installed pots if of sufficient size to give a proper sealing fluid surface are often used as they are more easily installed.

The calculation of sealing-pot sizes for use in installations, using a mercury-type recording gauge, is determined as follows: (Note: If bellows type gauges are used, the actual displacement of sealing fluid in the upstream and downstream parts of the gauge must be known in order to arrive at the corresponding displacement which would occur in the sealing pots.) In the following derivations the sealing pots are assumed as vertical. As the actual allowable vertical change of sealing fluid is small in most cases, change in displacement of sealing fluid in each pot can be closely figured for a horizontal sealing

pot if sealing liquid level is at center of pot by the (diameter of pot × length of pot) × (allowable increase in height of sealing liquid level computed for a vertical pot).

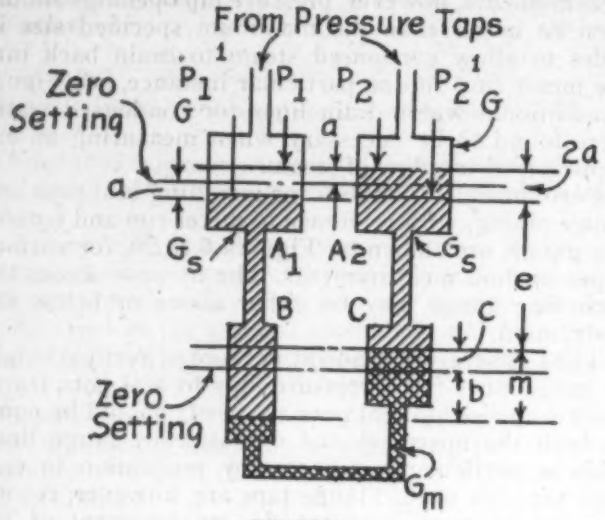


FIGURE 5

Case I. Sealing Liquid Heavier than Metered Fluid

(See Figure 4) (Assuming Vertical Cylindrical Seal Pots)
Let:
Areas in square inches of
Horizontal Liquid Surface Levels
$A = A_1 = A_2$ for each seal pot $= .7854\ d_a^2$
$B =$ High Pressure Mercury Chamber $= .7854\ d_b^2$
$C =$ Low Pressure Mercury Chamber $= .7854\ d_c^2$

Specific Gravities of Fluids (Water = 1.0000)
$G =$ Metered Liquid at Seal Pot Temp.
$G_s =$ Sealing Liquid
Note: G_s at pot assumed $= G_s$ in recorder
$G_m =$ Mercury in Recording Gauge

Vertical Heights in Inches
$a =$ Lowering of metered liquid and sealing liquid level in seal pot A_1 and
$a =$ Rise of metered liquid and sealing liquid level in seal pot A_2
$b =$ Lowering of sealing liquid and mercury level in H.P. pot of gauge
$c =$ Rising of sealing liquid and mercury level in L.P. pot of gauge.

Expressing Pressures in Inches of Mercury at 60° F. and Volumes in Cubic Inches

(33) $Aa = Bb = Cc =$ Change in displacements of liquids for differential $(P_1 - P_2)$

(34) $b + c = m$ or $b = m - c$ and from (33) and (34) $Cc = Bm - Bc$ or

(35) $c = Bm/(B + C)$ and from (33) and (35) $Cc = CBm/(B + C)$ which also equals (Aa) therefore

(36) $$a = \frac{BCm}{A(B + C)}$$

Since the pressure in each leg of the mercury column are

Steam Pots

Pressure taps should take off at center of horizontal run or above.

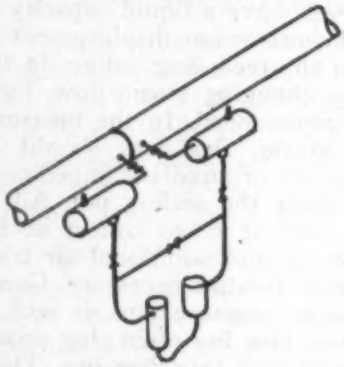


FIGURE 6
Horizontal meter run (gauge below)

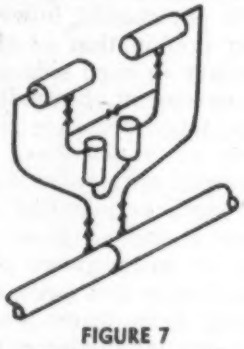


FIGURE 7
Horizontal meter run (gauge above)

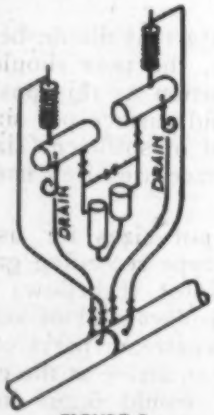


FIGURE 8
Highly superheated steam, variable flow. Note: Drain lines extend into and to center of pots in above case.

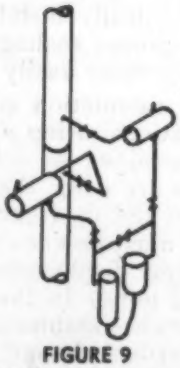


FIGURE 9
Vertical meter run

Gas With Liquid Seal

Pressure taps should not take off bottom of pipe.

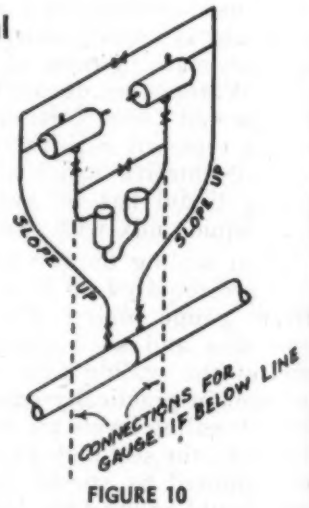


FIGURE 10

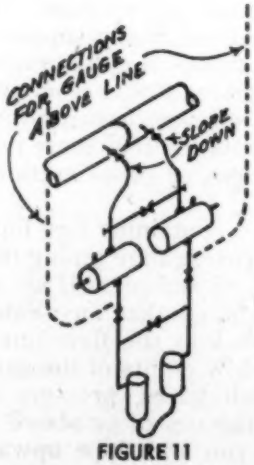


FIGURE 11

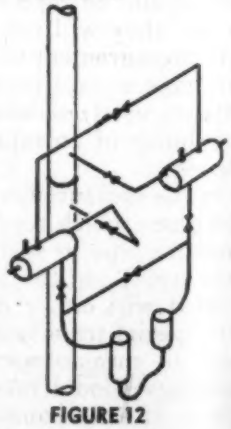


FIGURE 12

Water or Other Uncontaminated Low-Viscosity Liquids Containing Only Small Amounts of Free Gas

Pressure taps taken off within 45 degrees of center of horizontal meter run.

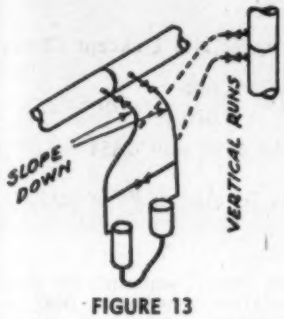


FIGURE 13
Gauge below line—no seal pot required.

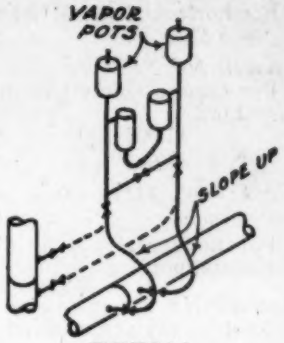


FIGURE 14
Gauge above line—no seal pot required.

equal at a level equal to that of mercury-seal fluid level in pot B

$$P_1' + \frac{eG_s}{G_m} + \frac{mG_s}{G_m} = P_2' + \frac{eG_s}{G_m} + m \text{ from which}$$

(37) $P_1' - P_2' = m(1 - G_s/G_m)$ or
$m = (P_1' - P_2')/(1 - G_s/G_m)$
Let n = true differential pressure across pressure taps $= (P_1 - P_2)$

(38) $P_1 = P_1' - 2aG/G_m$ and $P_2 = P_2' - 2aG_s/G_m$ from which $(P_1 - P_2)$ equals $n = P_1' - P_2' + 2a(G_s - G)/G_m$ or

(39) $n = m(1 - G_s/G_m + 2a(G_s - G)/G_m$ = actual differential in inches mercury

Since (m) is the actual change in mercury level in the recording gauge, it represents the indicated differential pressure. The recorder automatically converts (m) to inches of water or indicated differential h'.

Also $nG_m = h$, the actual differential across pressure taps in inches of water and (mG_m) = indicated differential h'. By multiplying equation (39) by G_m then

(40) $nG_m = mG_m(1 - G_s/G_m + 2a(G_s - G)$ which also equals

(41) $h = h'(1 - G_sG_m) + 2a(G_s - G)$ = actual press. drop in inches of water.

In orifice meter flow calculations the $\sqrt{h}$ is required and

Non-Viscous, Slightly Vaporous Light Liquids Having Only Small Fractions of Entrained Heavier Liquids

Special traps used.

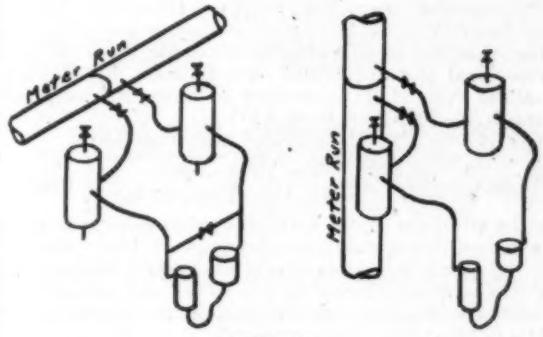


FIGURE 15
No special sealing liquid used. Pressure taps and gauge lines sloped down to gauge.

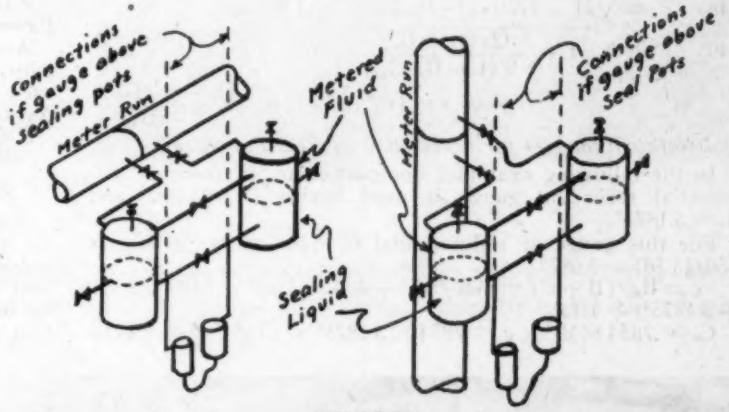


FIGURE 16
Special sealing liquid used. (Sealing liquid heavier than metered fluid).

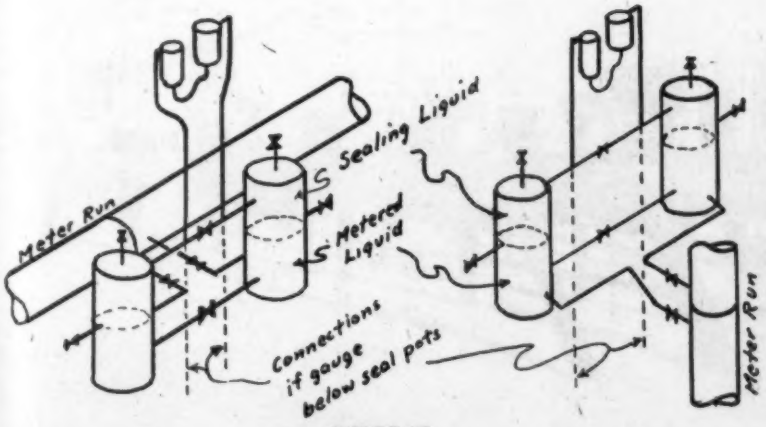


FIGURE 17
Special sealing liquid used. (Sealing liquid lighter than metered liquid).

GENERAL NOTES ON SEALING POTS

Place both sealing pots at same elevation.

Seal pots must be equipped with necessary valves or plugs for filling or venting, and for determining sealing-fluid levels.

Make size of seal pots such that the change in sealing liquid-metered fluid level is negligible during flow conditions.

Seal pots placed horzontally are generally recommended over vertically installed pots.

Sealing fluid-metered fluid levels should be maintained at center of horizontally installed sealing pots.

the correct value or $\sqrt{h} = F_s\sqrt{h'}$ or $F_s = \sqrt{(h/h')}$ or from (41)

(42) $F_s = \sqrt{(1 - G_s/G_m) + (2a/h')(G_s - G)}$ or

(43) $F_s = \sqrt{\left(1 + \frac{G_s}{G_m}\right) + \frac{2BC(G_s - G)}{AG_m(B + C)}}$

when (a) is given its value from (36) and (h') made = (mG_m), or

(44) $F_s = \sqrt{\left(1 + \frac{G_s}{G_m}\right) + \frac{2(d_c/d_s)^2(G_s - G)}{G_m[1 + (d_c/d_b)^2]}}$

when areas pots expressed in pot diameters

In common practice, the seal factor used equals $\sqrt{1 - G_s/G_m}$ and if the degree of error caused by this assumption is called (F_1),

(45) $F_s = F_1\sqrt{1 - G_s/G_m}$ or $F_1 = F_s/\sqrt{1 - G_s/G_m}$ and from (42), (43), (44),

(46) $F_1 = \sqrt{1 + \frac{2a(G_s - G)}{h'(1 - G_s/G_m)}}$ or $a = (F_1^2 - 1) \times \frac{h' \times (1 - G_s/G_m)}{2(G_s - G)}$, and also

(47) $F_1 = \sqrt{1 + \frac{2BC}{AG_m(B + C)} \times \frac{(G_s - G)}{(1 = G_s/G_m)}} = \sqrt{1 + \frac{2}{G_m}\left(\frac{d_c}{d_s}\right)^2 \times \frac{(G_s - G)}{(1 + (d_c/d_b)^2)}}$

From formulas (43), (44), (47), it is apparent that for any one set of pots of areas A, B, C that the correction factors F_s or F_1 are constant for any given values of G_s and G, regardless of flow rate.

Case II, Sealing Liquid Lighter Than Metered Liquid

By reasoning similar to that shown above for sealing liquids heavier than metered fluid, the following formulas have been devised for Sealing Liquids lighter than metered fluid.

(48) $F_s = \sqrt{(1 - G_s/G_m) + 2a(G - G_s)/h'}$ and

(49) $F_1 = \sqrt{1 + \frac{2a(G - G_s)}{h'(1 - G_s/G_m)}}$

or $a = (F_1^2 - 1) \times h' \frac{(1 - G_s/G_m)}{(G - G_s)}$

Illustrative Examples for Calculation of Seal Pot Sizes

In the following examples one particular 50" mercury differential recording gauge is used having $d_b = 2.125"$ and $d_c = 3.1875"$.

For this gauge at a differential $h' = 50"$, $m = (50/G_m) = (50/13.56) = 3.687"$

$c = B_m/(B + C) = md_b^2/(d_b^2 + d_c^2) = 3.687 \times 2.125^2/(2.125^2 + 3.1875^2) = 1.135"$

$C_c = .7854 \times d_c^2 \times c = .7854 \times 3.1875^2 \times 1.135 = 9.05$ cu. in.

Example No. 1, G and G_s being referred to water at 60° F. = 1.0000

For $G = .600$, $G_s = 1.000$, $h' = 50"$, permissible value $F_1 = 1.005$

Determine Seal Pot sizes, from (46)

$a = (1.005^2 - 1.) \times 50 \times (1 - 1/13.56)/2\ [1.000 - 600] = .579"$

$A = (C_c/a) = (9.05/.579) = 15.6$ sq. in.

For vertical pot $d_s = \sqrt{A/.7854} = \sqrt{15.60/.7854} = 4.46"$

For horizontal pot 3" diam., length pot $L = A/3 = 15.60/3 = 5.2"$

Example No. 2

For same conditions as in example No. 1 except allowable $F_1 = 1.002$

$$a = \frac{(1.002^2 - 1)}{(1.005^2 - 1)} \times .579 = \frac{.004}{.010} \times .579 = .232"$$

$A = (9.05/.232) = 39$ sq. in. and $d_s = \sqrt{39/.7854} = 7.05"$ for vertical pot.

For horizontal pot 4" diam., length = (39/4) =9.75" for horizontal pot

Example No. 3

Assume gas is measured with water seal and its flowing density at pot temperature compared to water = .0488 = G_s, (see pg. 135) and allowable $F_1 = 1.002$ and assuming $h' = 50"$ water

$$a = (1.002^2 - 1) \times \frac{50 \times (1 - 1.000/13.56)}{2(1.0000 - .0488)} = .0974"$$

$A = (9.05/.0974) = 92.9$ sq. in. or $d_s = \sqrt{92.9/.7854} = 10.9"$ for vertical pot

For 8" horizontal pot, length pot = (9.29/8) = 11.6"

If allowable $F_1 = 1.005$ in place of 1.002, $a = \frac{(1.005^2 - 1)}{(1.002^2 - 1)} \times .0974 = .2435"$

$A = (9.05/.2435) = 37.2$ or $d_s = 6.9"$ for vertical pot

For horizontal 4" diam. pot, length = (37.2/4) = 9.3"

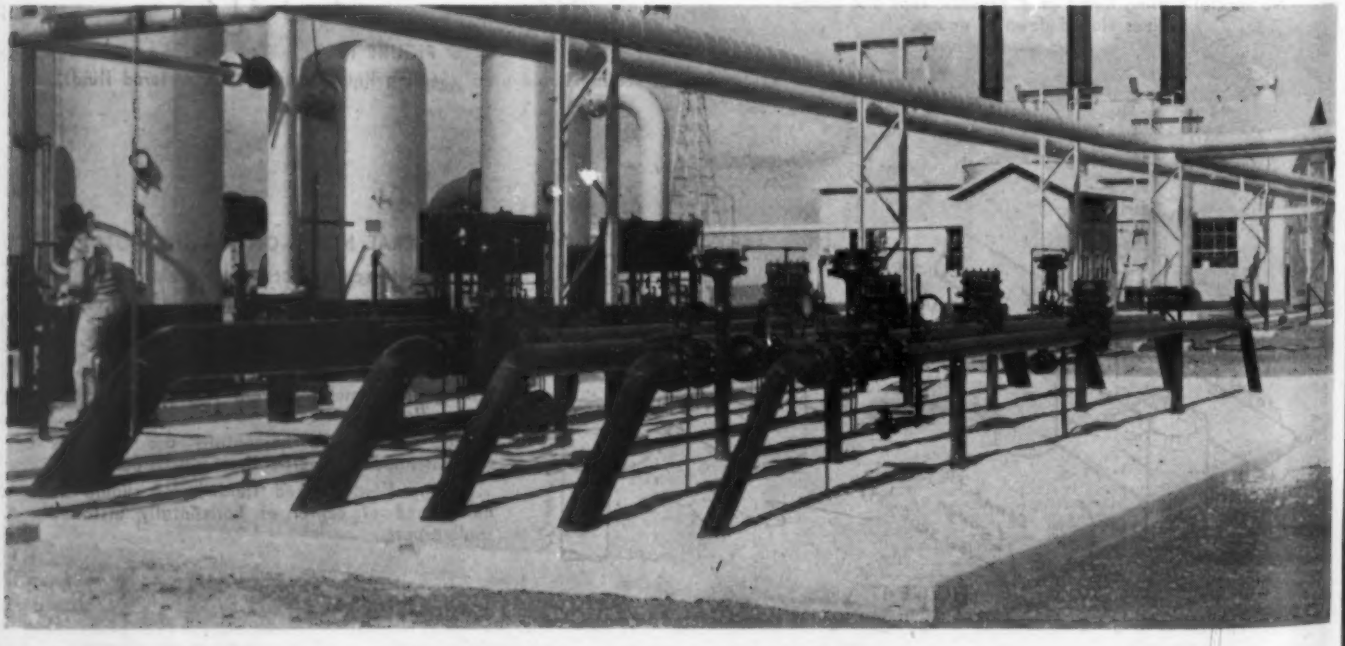
Example No. 4

Assume that the same gas as in Example No. 3 is metered with water seal and horizontal pots 4" diam. by 8" long are used making A = 32. It is desired to know the value of F_1. Assuming $h_1' = 50"$, then from (33)

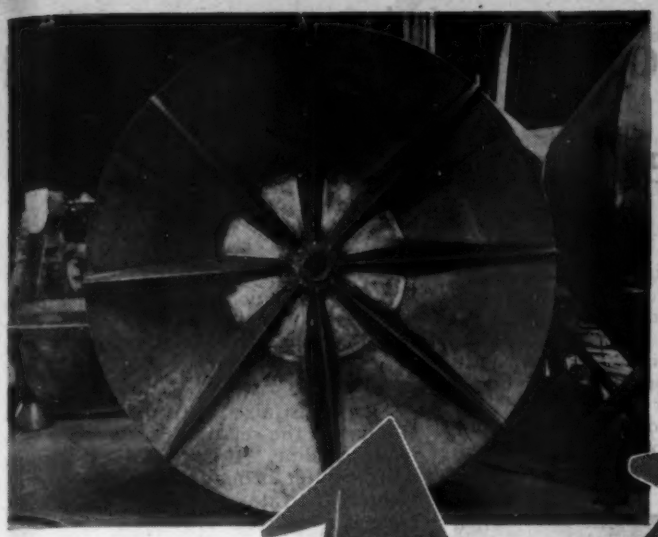
$a = (Cc/A) = (9.05/32) = .2828"$ and from (46)

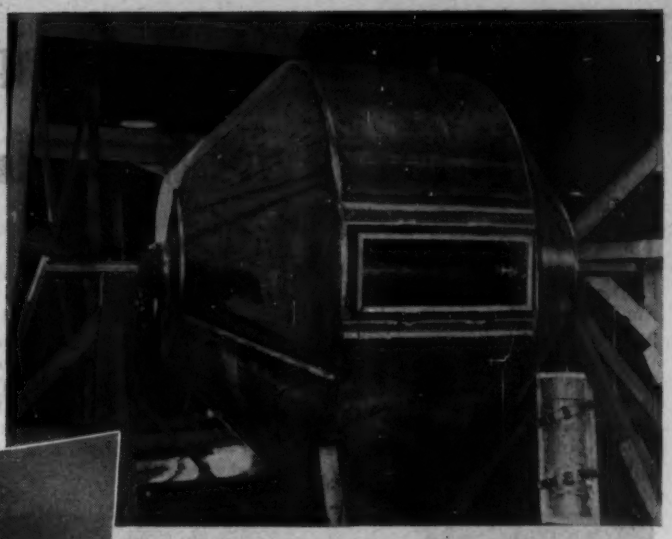
$$F_1 = \sqrt{1 + \frac{2 \times .2828}{50} \frac{(1 - .0488)}{(1 - 1.000/13.56)}} = 1.0058$$

Note: In all of the above formulas it has been assumed that G_s is constant throughout the hookup. If high accuracy is needed, the actual G_s value in seal pots could be used in that part of the equation shown as ($G_s - G$) and actual value of G_s in mercury chamber can be used in the mercury correction ($1 - G_s/G_m$).



Meter runs at a gasoline plant





FOR WORKABLE SHEET MATERIALS ...SEE REVERE

THESE pictures show plant equipment in special shapes and large sizes, fabricated of Revere sheet copper and sheet Herculoy by the Camden Copper Works, Camden, N. J. They illustrate the amazing versatility of these metals, which skilled coppersmiths the country over fabricate into practically any desired shapes from the flat.

Easy workability of course means faster and more accurate fabrication of apparatus for your plant. It may also mean lower prices from the fabricator, or lower labor costs in your own plant if you make your own equipment. Whether the final form be simple or complicated, the workability of copper and its alloys is a tremendous advantage.

More than this, copper's high heat conductivity may speed up processing, and cut fuel expense.

Copper resists attack by many substances, and thus has a long, sometimes endless life. Often copper pipes and vessels are replaced only because of a change in the plant; then the metal has a high reclaim value.

The Revere Technical Advisory Service will gladly cooperate with you in working out applications of copper, whether plate, sheet, strip or roll, or in other mill forms such as pipe and tube, rod and bar, and extruded shapes. Write Revere or see your Revere Distributor.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Ave., New York 17, N. Y.

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in principal cities, distributors everywhere

Listen to The Human Adventure *on the Mutual Network every Wednesday evening, 10 to 10:30 p. m., EWT*

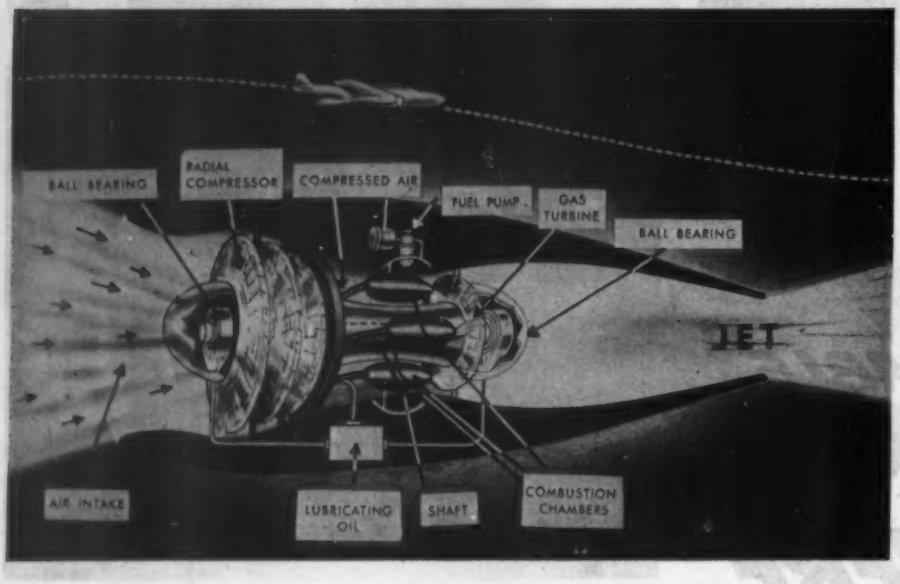
Shell Researchers Report Progress With Jet Plane Turbine Fuel and Lubrication

PROGRESS in the development of fuel and lubricant for the gas turbine in the jet-propelled airplane has been made public by Shell Oil Company, Inc., which has a laboratory devoted to these problems at Wood River, Illinois. Quotations from two recent press releases are given below:

"The chief difficulty with the gas turbine, is, or course, its very heavy fuel consumption. The efficiency of any heat engine depends on the range of temperature through which it can operate; and, unfortunately, the turbine cannot at present handle a temperature much in excess of 1200° F. In order to bring the temperature down to that level, we have to supply a very large amount of excess air, and since considerable energy is required to introduce it into the combustion chamber, this makes for less over-all efficiency.

"The gas turbine generally burns a high-grade kerosine, and although its requirements may not be as restrictive as those of the present high-output piston engines, it will nevertheless present problems of combustion and handling. Any old fuel almost certainly will not do, because the wrong fuel will soot or coke the combustion chamber and impair the over-all efficiency. It will also reduce the life of the chamber, a very important point if the gas turbine is to take its rightful place in competitive commercial service.

"In view of the relatively high fuel consumption of the turbine, the oil companies have cause to investigate the possibility of producing a fuel with a very high calorific value per unit volume, since we can deal more easily with weight than with bulk in the modern high-speed airplane. Unfortunately, problems in handling, such as low-temperature viscosity and freezing point, limit us in this direction. In view of all factors involved, it seems likely that a light kerosine will turn out to be the most satisfactory fuel for gas-turbined aircraft, delivering its power either through a propeller or a jet or a combination of both.



Hypothetical drawing of a jet engine mounted on a single shaft, which eliminates hundreds of points of friction in conventional engines.

"It should not be imagined, however, that gas-turbine fuel will necessarily be cheap when delivered into the aircraft. It is true that the price of kerosine is considerably less than that of 100-octane gasoline at the refinery. But the shipping and distribution costs of kerosine are likely to be much higher because of its smaller volume, so the final price of the kerosine as it is pumped into the aircraft may be only slightly lower than that of gasoline.

"There is also a tendency to overemphasize the relative safety of kerosine over gasoline. It is true that kerosine will be safer in many respects—particularly in the rate at which a fire spreads, once it is started. However, kerosine is easier to ignite, and a gas turbine has many more high-temperature surfaces from which ignition can start than a piston engine. Thus it is quite possible that there would be a greater incidence of minor fires in a jet aircraft, although probably a smaller incidence of serious ones.

"Supplying fuels for gas-turbine engines presents for the petroleum technologist and marketer an important and promising field, which will be cultivated as fast as the new needs arise. Meanwhile, it is still much too early to pronounce a funeral oration over piston engines in general, and the high-octane fuels which they require will continue in demand for many years to come."

Lubrication of jet propulsion engines by means of a mist-like spray consisting of 95 percent chilled compressed air and 5 percent oil, was described as follows:

"The spray is directed on the ball bearings at either end of the engine, on which the single longitudinal axle revolves, the air cooling the metal and the oil protecting it from foreign matter and rust. After its lubrication function is performed, the spray is exhausted into the jet.

"Engineers contrasted the lubrication problems of the jet-propulsion engine, where the axle is the only moving part, with those of the conventional internal-combustion aircraft engine, which has hundreds of moving parts and where the lubricant must cool, seal, lubricate, scavenge, act as a gear lubricant and as a hydraulic fuel. The jet-propulsion lubricant has only to cool and lubricate; yet it must meet certain important requirements not made of other lubricants.

"Because it passes from extreme low temperatures (usually well below zero) to temperatures of 800 to 1000 degrees in a matter of seconds, it must be a very stable oil capable of flowing through the lines at these low temperatures and yet not breaking down when suddenly exposed to intense heat.

"Even more important, the jet lubricant must provide complete protection from rust. The same Shell engineers who developed the rust-preventing turbine oil now used by the Navy are at work searching for a lubricant, as yet undiscovered, whose rust-inhibiting characteristics will be maintained under jet-engine conditions. The perfect jet-engine lubricant, they predicted, will be light and highly refined, because it must burn off clean, leaving no deposits on bearing surfaces."

CORRECTION

B. C. Thiel, author of the article "Plant Design of Compressor Piping," in the July issue, writes:

"After reading over my article in the July issue of PETROLEUM REFINER, I find that I have made two mistakes in the quantities for the average mass velocity.

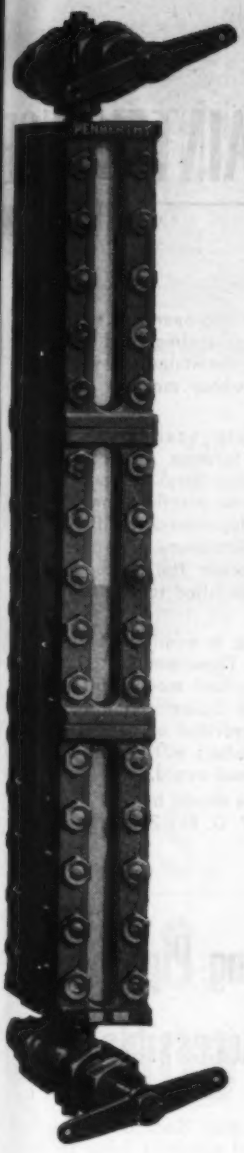
"In the 6th line from the bottom on page 103 (259) in the left-hand column the 2000 lbs./min./sq.ft. should read 690 lbs./min./sq. ft., and in the 3rd line from the bottom in the same column the 1500 lbs./min./sq. ft. should read 530 lbs./min./sq. ft."

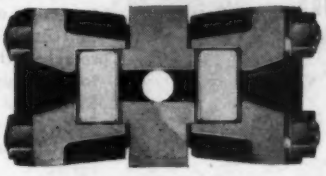
In the June issue, page 170, the heading "Digest of United States Patents on Hydrogenation of Hydrocarbons" should have read "Dehydrogenation," as is obvious from the text. Librarians and others keeping a subject index will please note this correction.

FOR EVERY GAGE REQUIREMENT

Whatever your liquid level gage requirements, there is a Penberthy Gage that will meet your needs. These gages are suitable for the various pressure and temperature conditions of the oil industry. All Penberthy Gages conform with A.P.I.-A.S.M.E. requirements.

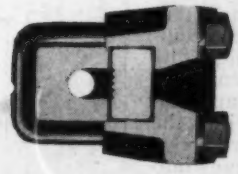
Write for a copy of Catalog 34-A.





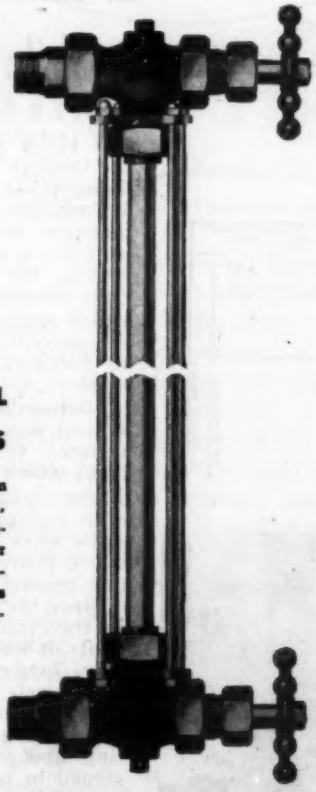
PENBERTHY
Transparent
DROP FORGED STEEL LIQUID LEVEL GAGES

Used to observe color and density of liquids under high pressures, and/or temperatures. Construction is exceptionally rugged . . . . similar to Reflex types.



PENBERTHY *Reflex*
DROP FORGED STEEL LIQUID LEVEL GAGES

Liquid shows black — empty space shows white. Preferred wherever liquid level must be easily and positively visible . . . and when liquids are under high pressure or at high temperature.



PENBERTHY
DROP FORGED STEEL LIQUID LEVEL GAGES

Made of Chromium-molybdenum alloy temperature-resisting steel, extra heavy throughout. Stainless steel trimmed. Tubular glass type gages also available in various other metals suitable for practically all conditions.

PENBERTHY *Reflex*
WATER GAGE SET

Water shows black — steam shows white. U-Bolt construction is strongest and simplest to service. Glass replaced by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler.

☆

PENBERTHY PRODUCTS

PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN • **Canadian Plant: Windsor, Ontario**

OPERATION HOW TO DO IT MAINTENANCE

1. Third Control Function Closely Regulates Debutanizer Column

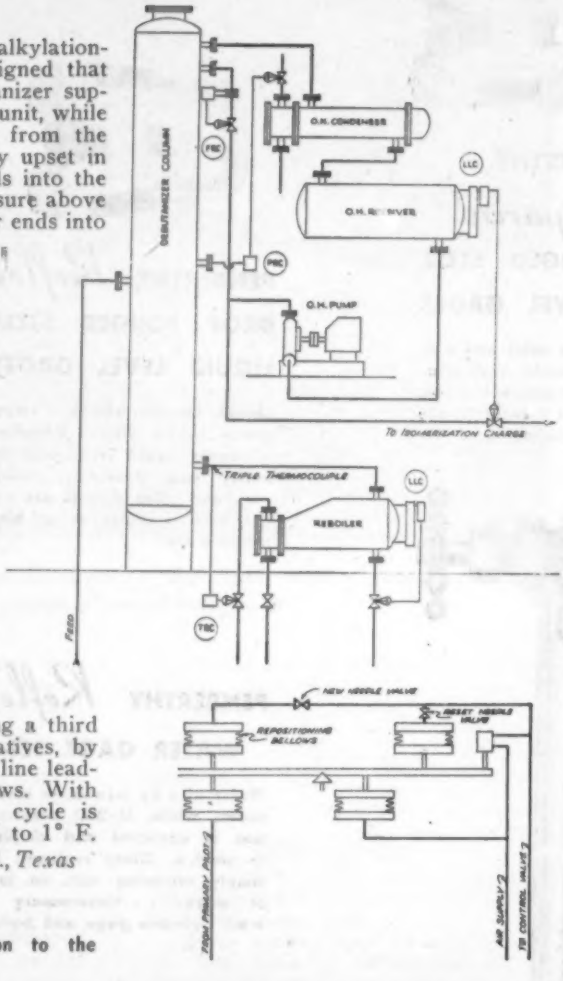
THE control system of our alkylation-isomerization plant is so designed that the overhead from the debutanizer supplies feed to the isomerization unit, while the bottoms are the product from the alkylation unit. Therefore, any upset in control either forces light ends into the alkylate, raising its vapor pressure above specifications, or forces heavier ends into the isomerization charge, with the result that the conversion rate drops off.

Only by maintaining extremely close control on the debutanizer reboiler can the system operate satisfactorily.

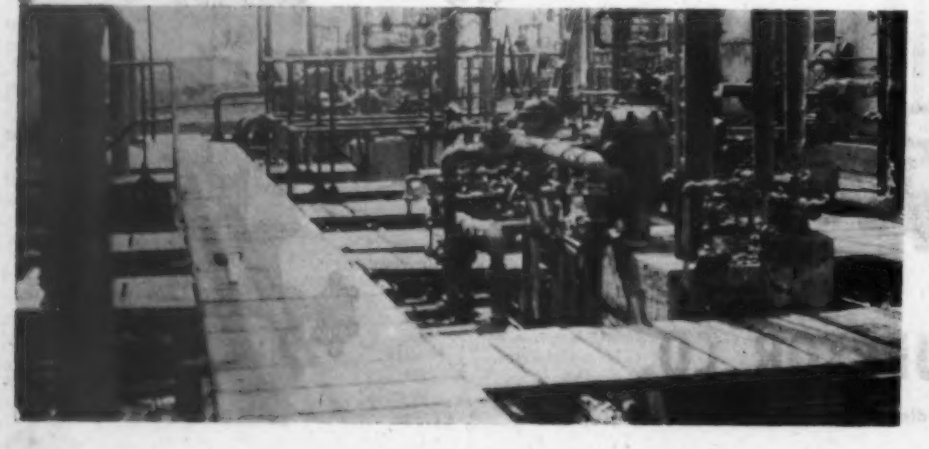
The control originally installed consisted of a pneumatic temperature instrument with a triple thermocouple on the reboiler outlet. This instrument operates on two main control functions—throttling range and reset. These, however, did not provide adequate control, since they permitted a temperature cycle of from 10° to 15° F., even when the lowest throttling range and reset were used.

This was corrected by adding a third control function, second derivatives, by installing a needle valve in the line leading to the repositioning bellows. With this addition the temperature cycle is kept within a range of from ½ to 1° F.

—D. M. B., *Texas*



The lower drawing shows addition to the central system.



Walkways between receivers and pumps in treating plant where underground lines are exposed by excavating to stop corrosion. Plan is to replace wood with steel when available.

EACH month the operating personnel in the refining, cycling and natural-gasoline plants determine the winner of a War Bond whose maturity value is $25.00.

Superintendents, assistant superintendents and foremen (subscribers as well as non-subscribers) become a jury to select the most practical contribution to this new department of Petroleum Refiner on maintenance and operation. The editors rotate the voting among men who are qualified to determine the rating.

This award is in addition to payment for the article. These methods of solving plant operation and maintenance problems come from the personnel of the industry. Items provided by Petroleum Refiner staff members will not be eligible for the War Bond award.

Contributions should be sent to Petroleum Refiner, P. O. Box 2608, Houston 1, Texas.

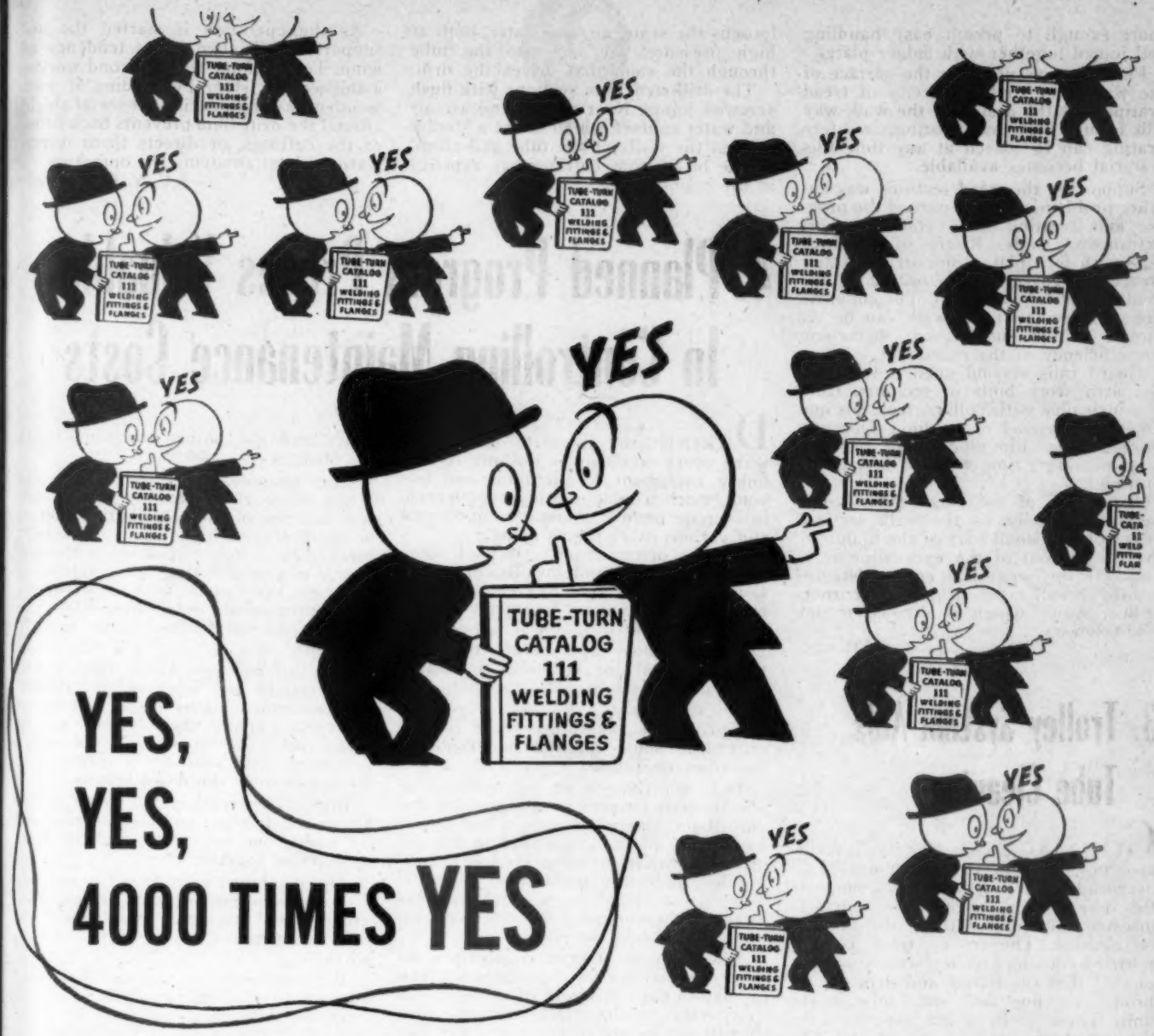
2. Corroding Pipes Made Accessible

WHEN it was decided to uncover the treating and product lines in the refining plant of Fletcher Oil Company, Wilmington, California, L. A. Hulsey, manager, worked out a system whereby excavation was carried out without disturbing the piping system. Then concrete flooring was laid over the excavated area. Sectional walkways were designed for crossing to permit access to pumping units and treating equipment.

Desirability of uncovering the piping system was based on the fact soil contributes to corrosion, causing small leaks which are difficult to detect.

The trench was smoothed and concrete mat poured over the surface. Side walls were provided by setting forms, which provided a curbing to match normal ground level.

Since the area of exposed piping must be traversed constantly by the working shifts, it was necessary to provide walkways between tanks, pumps and treating vessels. Since walkways of permanent construction would have offset the advantage of ready access to piping, fitting and valves, the walks were designed in removable sections, with sills supporting the runways of angle iron. Joints between sections were made



TUBE TURNS Catalog 111 can answer "yes" to over 4,000 "have you got it?" welding fitting questions. This complete line of Tube-Turn welding fittings, available through selected distributors in every principal city, is saving time and money for large and small users all over America.

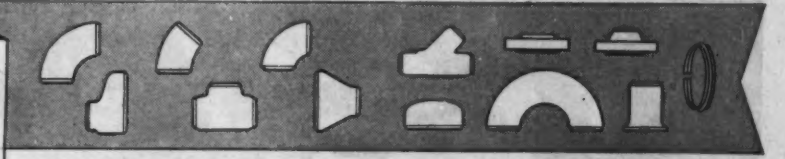
Being able to get *all* the welding fittings for any job from a single source is more important than ever, as thousands of plants plan urgently needed repairs and replacements. Tube-Turn welding fittings were the *first* seamless welding fittings. The many years of experience gained in building the complete Tube Turns line can be of help to you in solving your own piping problems. That experience is freely offered through your Tube Turns distributor, backed by the nearest branch office and the vast resources of the home office.

Your Tube Turns distributor is worth knowing. He carries a comprehensive stock, and is prepared to furnish exactly what you need, rather than something "just as good." Write today for your free copy of Tube Turns Catalog 111, a valuable handbook of welding fittings information.

Selected Tube Turns distributors in every principal city are ready to serve you from complete stocks.

TUBE TURNS (Inc.), Louisville 1, Kentucky. Branch Offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D.C., Houston, San Francisco, Seattle, Los Angeles.

TUBE-TURN
TRADE MARK



THE COMPLETE LINE OF WELDING FITTINGS AND FLANGES

short enough to permit easy handling and joined together with ledger plates.

Planking was used for the surface of the walks due to the scarcity of tread grating, but the design of the walk-way sills is such that steel flooring, or safety grating can be placed at any time this material becomes available.

Supporting the tread sections was another problem, since no part of the process and treating lines could support extraneous loads. Risers of two-inch pipe with foot plates support the entire structure. These are connected to the angle-iron sills with bolts. The supports are so placed that the walk can be removed in sections without disturbing the efficiency of the remainder.

Guard rails around open portions of the area were built in sections, from one-inch pipe with collars, tees, ells and cross tees instead of welding. This was done so that the pipe might be used at some future time without damage by cutting.

Inspection of the affected lines may be done visually, as the walk sections cover only a small part of the manifold. As the bottom of the excavation is of concrete, any small leak can be detected readily. Small sumps at opposite corners collect water which is drained to the plant sewers.

—E. S., *Texas*

3. Trolley System Aids Tube Cleaning

CLEANING exchanger tubes is facilitated in one refinery through use of an overhead trolley system that supports the tube-cleaner motor while a drill is inserted the full length of the tube to be cleaned. The trolley track is supported by a short trolley section at each end so that the motor and drill can be brought in line with each tube in the unit. These trolleys are supported by fabricated pipe sections at each end. The whole contraption is readily moved to location as needed.

In addition to the boring action which loosens the scale, air and water, both at high pressure, are fed into the tube through the stem that drives the drill.

The drill stem is in sections with flush screwed joints. Near the bit end are air and water courses which direct a stream against the walls of the tube and ahead of the bit so that cuttings are expelled at the opposite end.

As the operation is started the unsupported drill stem has a tendency to whip. To overcome this, a second worker stabilizes the stem by holding it with wooden bushings. A circular metal shield around the drill stem prevents back firing of the cuttings, or directs them downward without annoying the operators.

—J. C. A., *California*

4. Planned Program Proves Valuable In Controlling Maintenance Costs

DURING the present emergency when every company is pushing its refinery equipment to the limit and beyond, much trouble is being experienced in keeping pumps, engines, compressors and various other pieces going.

Scarcity of repair parts, lack of manpower, improper and insufficient attention have all combined to create a nightmare for maintenance foremen.

In the past it has been customary here, as in most other plants, to run a particular machine or pump or engine just as long as it would go without flying to pieces.

Usually we made necessary repairs only after some operator had reported the equipment B.O.

It is not the job of the operator in the modern refinery to assume the duties of the maintenance crew and try to look after all the machinery in his department while on duty. He has a multitude of legitimate duties which, if properly attended to, will take all his time. If the company did not think so, he would not be there.

The business of maintenance in a refinery in this age has become more than a "day-to-day" program of more or less temporary repairs made with the idea it will get by today and tomorrow can take care of itself.

Since this is being directed to maintenance foreman I will speak their language and not bother too much with the obvious.

Our maintenance costs here, like yours, have risen steadily during the war and one of the contributing factors being of course, high wages of embryo mechanics entirely out of line with their ability to produce. But, this condition is the same everywhere with no prospects of improvement until after the war when good mechanics again will be available.

Now all foremen know that a machine can be and is abused far beyond the recommendations of any manufacturer, but finally there comes a time when makeshift repairs will not suffice and more often than not a major overhaul and costly shutdown results.

Inside our refinery we have a gas plant, a Poly plant and a stabilizing unit all under one supervisor and all three units close together.

The combined number of steam- and motor-driven pumps, gas compressors, engines and turbines totals some 60, and maintenance costs were running away.

We assigned one of our best mechanics to the full-time job of taking over the three units and making a survey of all equipment and furnishing an estimate of repairs (such as could be readily observed on the outside) needed to put every machine in good condition.

We set up a card file and gave each piece of equipment a number (as 1, 2, 3, 4 etc.)

When the survey was completed sufficient help was furnished the mechanics to commence the repair program.

Using 100 percent as a basis, we set a percentage condition on each machine both before it was torn down and after the repair was completed. Space was provided on the card for make of unit, size, serial number, product handled, type and size packing and type of machine, and in addition space was also provided to enter the service record of the particular unit.

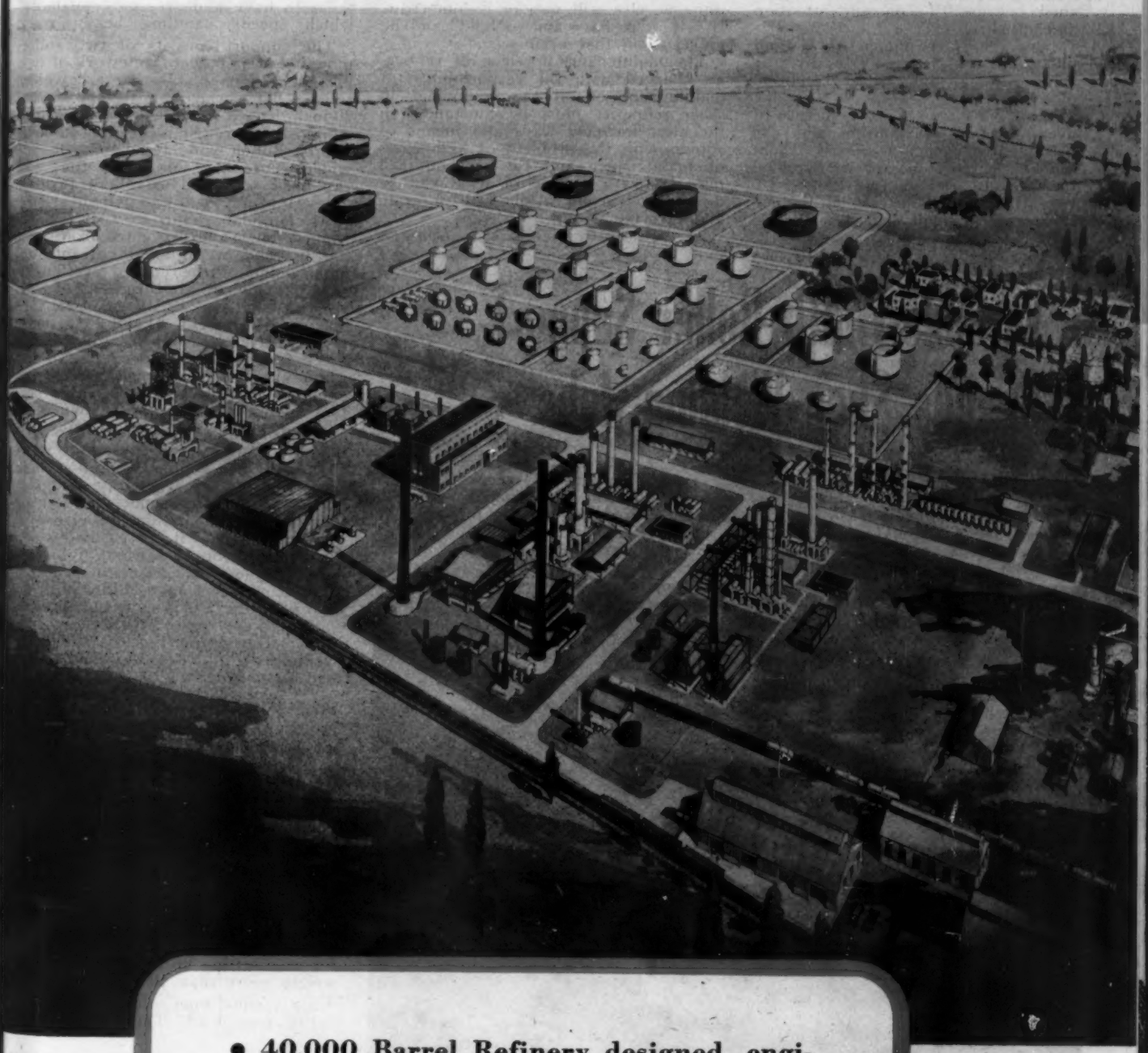
After the repair program was completed the mechanic found (as we had hoped) that with only the occasional need of a helper, it was a comparatively easy matter to keep the three units in first class operating condition by virtue of being on the job full time and thus being in position to observe and correct the little troubles before they became big ones.

The plan has been in operation for some years now and has proven a decided success.

The records made on the cards have

Trolley supports motor and permits putting cleaning drill in line with each tube in the unit

NDIVIDED RESPONSIBILITY IN ONE ORGANIZATION



• 40,000 Barrel Refinery designed, engineered and now being constructed by the McKee organization under a single contract.

Arthur G. McKee & Company

★ Engineers and Contractors ★

2300 CHESTER AVENUE • CLEVELAND, OHIO

ROCKEFELLER PLAZA, NEW YORK, N. Y. • COMMERCE BUILDING, HOUSTON, TEXAS

been very valuable in many ways as, for example:

1. We have found the type packing most suitable for a certain condition.
2. We determined what material was best for pump shafts and rods handling different products.
3. Bearing life has been greatly lengthened because of constant attention and adjustment.
4. Down periods are much shorter and on-stream runs much longer by reason of the all-time better condition of equipment.
5. We have a comprehensive picture of every machine's condition and can predict with accuracy just about when it will be due for an overhaul or checkup.

We attribute the success of the experiment in no small degree to the assigning of one particular man to the job and then leaving him there. His familiarity with the work and machinery under his immediate jurisdiction has enabled him to build the job into a worthwhile one in which he takes pride, and accepts the responsibility which goes with it.

He knows if he slights a job today, someone else will not fix it tomorrow. It is his "to have and to hold" and he proceeds on that premise.

The maintenance foremen of refineries charged with the responsibility of maintenance of all the equipment in those refineries must be constantly on the alert for new ways and means of coping with the problem of high costs of maintenance and the one outlined here is but a sample of what can be done by devising a planned program and carrying it out.

B. D. T., *Kansas*

5. Variable-Width Roller Support Speeds Shop Welding Jobs

ECONOMICAL repair and fabrication of large, awkwardly-handled pressure vessels in the average oil company welding shop is possible only if adequate provisions are made to cut down the man-hours usually required to take care of that special type of work. On large cyclindrical vessels for example, the work is largely one of welding—long, uninterrupted seams that require close coordination between welder and the helper who rotates the vessel in maintaining th weld smoothly and evenly placed. In the repair shop of one major producing company, the welding foreman devised a roller-contained device which enables the men to adapt it to nearly any size vessel, yet permits them to have a degree of "rollability" which speeds handling heavy work.

The support consists of two rollers mounted atop a steel framework of twin upright ½-inch plates that are welded to the flat surface of an over-turned 30-inch length of 8-inch channel iron. The rollers are 10 inches in diameter with a 2-inch wide tread, providing a wide, secure base on which the work can turn safely. The rollers turn on axles, the outer ends of which are cut to rectangular shape so they can be slipped down and prevented from turning in the several slots cut into the upper edge of the curved sections of steel plate. There are three sets of these slots at each end of the support, their distances being 5½, 8, and 11½ inches respectively from, and on either side of the center of the device. The photograph shows the rollers in the farthest extended pair of slots, and in this position a 4-foot vessel may be handled.

Solidly built, the roller support is made to stand the rough usage to which such tools are subjected in the shops. Two fillets on each side of the upright plates give ample support in supplementing the base welds. Because of its convenient size, it is easily skidded about the floor to various jobs, two small handles welded to either end providing convenient hand-holds. With several of these easily-constructed roller supports kept handy beside the welding bench, nearly any type of tubular or cyclindrical job can be handled and many man-hours of time saved.

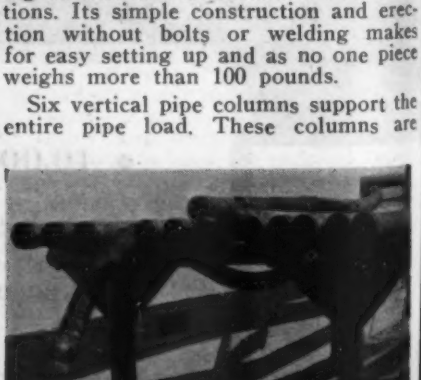
—J. A., *Oklahoma*

Notches in the curved sides of this roller support are engaged by the extended axles of the two rollers and permit a wide variation in spacing of the two supporting surfaces so as to accommodate large diameter pipe, heavier cylindrical vessels and even tanks of a diameter which may be handled within the shop. The two hand grips permit safe placing of the roller unit.

6. Portable Steel Pipe Rack Handy Time Saver

THIS all-steel rack has been so designed that it is extensible in two directions. Its simple construction and erection without bolts or welding makes for easy setting up and as no one piece weighs more than 100 pounds.

Six vertical pipe columns support the entire pipe load. These columns are



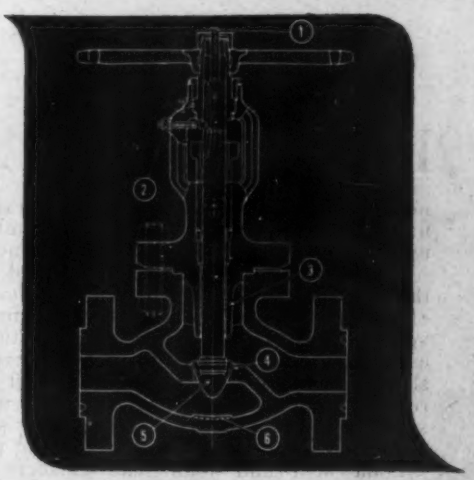
Pipe rack is time saver

HOW EDWARD ENGINEERING LICKED THE THROTTLER VALVE PROBLEM FOR ONE COMPANY....

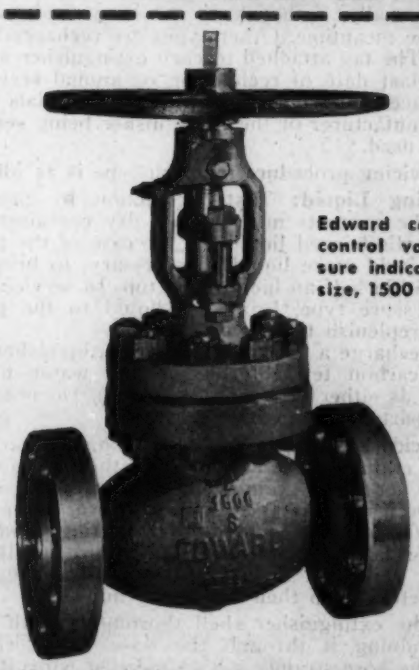
PROBLEM: Valves for throttling service have always been tough to build. The punishing wear of partly-open operation takes its toll on even the best standard globe type valve, and of course a gate valve in throttling service is seldom satisfactory. Not long ago a large Eastern utility came to Edward with a request for a valve specifically built for severe throttling service. Edward engineers, working with the customer, produced the valves described below. Originally designed for use on a feedwater pump by-pass line, they are ideally adapted to general throttling service.

Here's what happens to even high quality valve parts in the most difficult type of throttling service. Notice how fluid, at high pressures and high velocities, has cut away the metal of the disk.

SOLUTION: Here is a valve with all the features that are important in throttling. An indicator **(1)** attached to the stem shows position of the disk at all times. An Alemite fitting **(2)** eases operation. A long stem guide **(3)** keeps the stem and disk in perfect alignment at all times. The seat **(4)** is a heavy layer of Stellite, applied directly to the valve body, and the disk **(5)** parabolic in design for volume control and integral with the stem, has Stellited seating faces, too. A bearing surface of EVinlay **(6)** on the valve body gives additional protection against high velocity flow. It is recommended that the valve be installed with pressure over the disk.



RESULT: The ideal steel valves for many types of throttling service. And, for other conditions and for various sizes of lines, Edward has solved the throttling valve problem with special materials and designs. This Edward engineering experience is yours to command.



Edward cast steel flow control valve with closure indicator, in 2 inch size, 1500 lb ASA rating.

EDWARD *Steel* VALVES
THE EDWARD VALVE & MFG. CO., INC.
EAST CHICAGO, INDIANA

Look to Edward for the Best in New Steel Valve Developments

made of heavy 4-inch pipe with suitable braces. The pipes are cut in 3-foot lengths and have their ends mitered to make a snug fit with the pipe cradles welded to these ends. The pipe cradles or sockets are likewise made of heavy 4-inch pipe that has been split lengthwise with the cutting torch. These half sections are two feet long. They are welded to the pipe columns at right angles to one another. Strong triangular gussets of quarter-inch plate cut 10 inches on a side, have been welded two to the joint on each pipe stand. Each stand thus consists of a vertical pipe column and two half pipe cradles.

In erecting the pipe rack, two heavy 3-inch pipes are laid on the ground, spaced the desired distance apart. These pipes run lengthwise with the pipe to be placed on the rack. The 6 fabricated pipe columns are then spaced 3 to a side at equal distances. Three more pieces of 3-inch pipe are then laid on top of the pipe columns at the desired width. The pipe to be racked is then placed on top of these cross pipes.

—C. S., *Louisiana*

READERS ARE URGED TO CONTRIBUTE items to this department. Drawings or photographs are desired where practical. Payment for items accepted will be on a basis that will compensate for the time involved and in addition each contribution will be eligible to receive the bond award as outlined in the announcement on page 146. Jury awards will be announced in the second issue of PETROLEUM REFINER after publication.

Care and Servicing of Fire Extinguishers

Suggested by Safety Research Institute in Connection with Fire Prevention Week—October 7 to 13

HAND fire extinguishers must be kept ready for instant use or they may fail to operate properly when needed. To maintain them in good working order, they must be inspected frequently, refilled immediately after use, and thoroughly serviced at least once a year.

The annual servicing may be carried on throughout the year by a few experienced men, who also take care of recharging. If a large number of extinguishers is involved, the work can be done at one time by a group especially assigned to this duty. Inexperienced men should be supervised to assure correct treatment and reassembly of each extinguisher. In no case should so many extinguishers be removed for servicing at the same time as to leave any area without protection.

Soda acid and foam extinguishers must be recharged annually, if they have not been used and refilled in the meantime. Other types are recharged only after use. The tag attached to each extinguisher should show the last date of recharging or annual servicing. Only replacement parts or recharging materials made by the manufacturer of the extinguisher being serviced should be used.

The servicing procedure for each type is as follows:

Vaporizing Liquid: Test the action by pumping some of the contents into a clean, dry container, and return the discharged liquid. In the case of the pump-gun types, add more liquid, if necessary, to bring the level to within half an inch of the top. In servicing the stored pressure type, bring the liquid to the proper level and replenish the air pressure.

Never recharge a vaporizing liquid extinguisher with ordinary carbon tetrachloride or use water to test operation, as either will cause corrosion. Do not lubricate any part of the extinguisher.

Soda Acid: Be sure the nozzle opening is clear: then invert the extinguisher and discharge the contents. Unscrew the head and examine the gasket, which should be replaced if it is damaged or badly worn. Remove the cage containing the acid bottle, putting aside the stopple for later replacement. Make sure all the extinguisher parts are kept together so that they may later be returned to their respective units.

Rinse the extinguisher shell thoroughly with warm water, draining it through the hose. Open clogged holes in the hose strainer with a piece of wire. Replace the hose and nozzle, if badly worn or damaged.

Dissolve the dry chemical in lukewarm water, according to directions on the recharge package. Pour the solution into the extinguisher shell, and bring to the filling mark by adding water. Remove the cork from the new acid bottle and replace it with the stopple from the old bottle. Replace bottle and cage in the extinguisher neck. (If any acid spills on the skin or clothing, wash it off with water.) Rub a little vaseline on the shell threads and replace the head, using only hand power. Be sure that the gasket fits snugly against the shell neck.

If the extinguisher looks badly dented, or the seams appear weakened, do not discharge. Instead, remove the head and pour out the contents. Return to the manufacturer or his agent for repair.

Foam: As in the case of the soda acid, discharge by inverting. Remove the head and lift out the inner tank. Rinse the extinguisher thoroughly, draining water out through the hose. Dissolve the charging material according to instructions on the packages, using hot water for the A charge and lukewarm water for the B charge. Pour solution A into the inner cylinder and solution B into the outer tank, bringing both up to the filling marks by adding water. Replace the stopple on the inner tank and return it to the extinguisher shell. Replace the head, as for the soda acid.

Loaded Stream and Gas Cartridge: Since these types operate by gas released from a carbon dioxide cartridge, they should not be discharged for the annual servicing. Remove the head and gasket and inspect parts as outlined under the soda acid. Remove the cartridge and weigh on an accurate scale. A loss of half an ounce or more indicates leakage and a new cartridge should be inserted. If necessary, add water to bring the liquid in the tank up to the filling mark. Then replace the head.

Carbon Dioxide: Examine hose and horn for defects and see that the seal on the operating valve is intact. Weigh the unit. If there is a loss of weight, the extinguisher should be recharged. Recharging service is offered by the extinguisher manufacturer or his agents or by carbonic gas plants.

Pump Tank: Test by operating the pump several times, discharging the solution back into the extinguisher tank. A drop of thin lubricating oil may be placed on the piston rod packing. Bring up to the filling mark by adding water, if necessary.

CARRYING ALL THE LOAD ALL THE TIME

Grinnell CONSTANT-SUPPORT Hangers

The ONLY Constant-Support Hangers!

Constant support of piping in all "Hot" and "Cold" positions

Full safety factor of the supported system is always maintained

Non-resonant, energy absorbing

Mass produced from standard precision parts

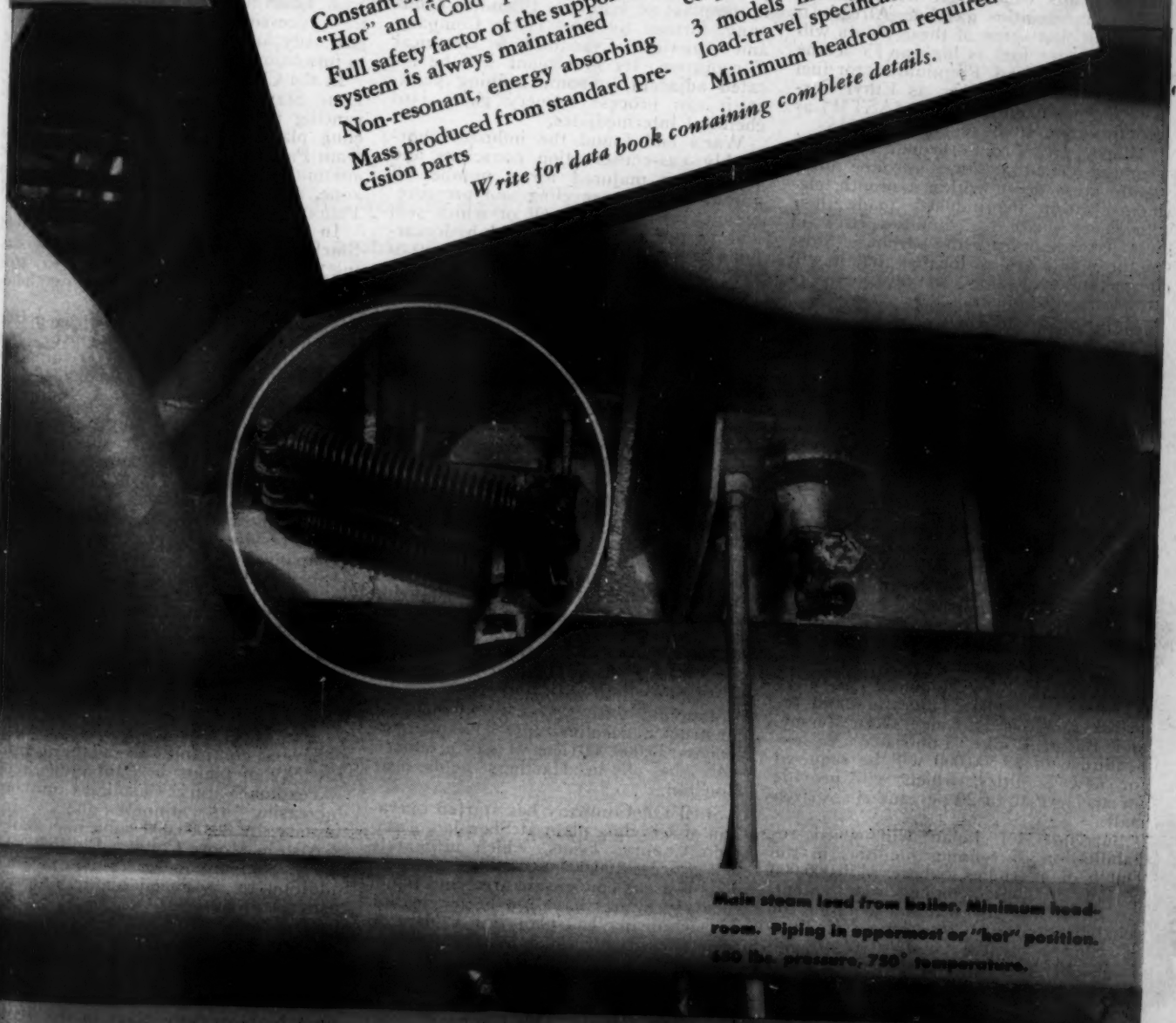
Individually calibrated for each specific installation

Load-adjustment features are incorporated into the design

3 models meet entire range of load-travel specifications

Minimum headroom required

Write for data book containing complete details.



Main steam load from boiler. Minimum headroom. Piping in uppermost or "hot" position. 450 lbs. pressure, 750° temperature.

GRINNELL COMPANY, INC.

EXECUTIVE OFFICES, PROVIDENCE 1, R. I.

BRANCH WAREHOUSES

ATLANTA 2, GA. — LOS ANGELES 13, CAL. — PROVIDENCE 1, R. I.
CHARLOTTE 1, N. C. — MINNEAPOLIS 15, MINN. — ST. LOUIS 10, MO.
CHICAGO 9, ILL. — NEW YORK 17, N. Y. — ST. PAUL, MINN.
CLEVELAND 14, O. — OAKLAND 7, CAL. — SAN FRANCISCO 7, CAL.
HOUSTON 1, TEX. — PHILADELPHIA 34, PA. — SEATTLE 1, WASH.

GRINNELL

FOUNDED 1850

WHENEVER PIPING IS INVOLVED

War's End Releases Pent-Up Plant Building Program

WITH lifting of many building restrictions and indications of further relief the pent-up construction program of the refining industry broke into the open. The industry must improve its facilities to permit overall manufacturing accomplishments comparable to the possibilities in plants which have been making high-octane aviation gasoline. Already it is evident that some of these plants will finish a motor fuel as high as 75 octane rating without lead. Premium motor fuel will be higher than this, as Ethyl Corporation has fixed 78 octane (ASTM) as its minimum, effective November 15.

When advices came through that government-owned aviation gasoline units would close down within a month, elements within the industry made their moves to put these facilities back in service through lease and purchase. Most of the plants are so located that it will be advantageous for wartime operators to continue the operation.

Major construction projects already under way or announced were sufficient to make 1946 an outstanding construction period. Standard Oil Company (Indiana) will provide fluid type cracking units at both Whiting, Indiana, and Sugar Creek, Missouri. Additional facilities will bring total cost of these facilities to $56,000,000.

Shell Oil Company has foundations under way for its fluid type catalytic cracking unit at its Houston plant. Utilities, water cooling, machine shop and rehabilitation of other units will involve expenditure of $11,000,000 at this plant.

Standard Oil Company of New Jersey will carry through an expansion and rehabilitation at its Bayway plant involving expenditure of $4,000,000.

Standard Oil Development Company will provide modern laboratory and research facilities at Liden, New Jersey, and Baton Rouge, Louisiana. An expenditure of $8,500,000 will be required for new facilities, which will provide for an increase of 20 percent in research staff.

Surrender of Japan will speed rehabilitation of refining facilities in the Dutch East Indies, where $150,000,000 is the anticipated money requirement. An equal amount will be required for rehabilitation and expansion of facilities in Europe, where studies are being made. Projects in South America will involve $75,000,000.

In keeping with the trend of using light hydrocarbons for high-octane ingredients in gasolines, the lifting of restrictions brought to light several natural gasoline and cycling plants. This type of plant must follow field development and over the past three years shortage of materials has hampered provision of liquid-extraction units.

Although no application has been made, the first of the plants for converting natural gas into gasoline is scheduled for the Carthage area, East Texas, where several other cycling and natural-gasoline plants are being built. The conversion plant (an adaptation of Fischer-Tropsch processing) is expected to cost $15,000,000 which will include facilities for returning part of the dry gas to the formation for pressure maintenance.

Another project, which has had some public notice but is still without release, is the plant of Jefferson Chemical Company, formed by The Texas Company and American Cyanamid & Chemical Corporation. Its first plant will be located adjacent to some refining plant, so it can process refinery gases into chemical intermediates.

War's end found the industry thoroughly gas-conservation conscious and with plans matured for a number of gasoline plants, recycling and pressure-maintenance projects, all of which will add to the volume of liquid hydrocarbons manufactured. Notably, many of the more ambitious projects involve utilization of oil-well gas in the Southwest that heretofore has been flared.

Humble Oil & Refining Company on August 20 announced plans for four projects designed to conserve for productive use 56,000,000 cubic feet of gas daily, from five Gulf Coast fields. Gasoline plants are to be built at West Clear Lake and at Anahuac, and compressor stations at Lovell Lake and North Crowley. The Clear Lake plant will process 5,000,000 feet from Clear Lake field, 20,000,000 feet from Friendswood, and 6,000,000 feet from Dickinson-Gillock; and will recover 25,000 gallons of liquid products daily. Anahuac plant will process 12,000,000 feet daily from that field, and produce 5400 gallons of products. The Lovell Lake and North Crowley projects involve installation of additional compressors to gather and deliver gas to transmission lines.

Stanolind Oil & Gas Company will construct a gasoline-repressure plant to process 30,000,000 feet of gas produced with the oil in Hastings field, near Houston.

Shell Oil Company has started operation of a cycling plant at Sheridan, Colorado County, Texas, which ultimately will process 100,000,000 cubic feet daily. This is a gas-condensate area, and liquid recovery figures have not been released. This company has plans for a plant to serve Brushy Creek and Hope fields in Dewitt and Lavaca Counties.

Glenn H. McCarthy is nearing completion of a cycling plant at Winnie in Chambers County. This plant will process 85,000,000 feet of gas.

Katy Operators Committee plans a gathering system to collect 12,000,000 cubic feet of gas daily from oil wells on the flanks of the Katy gas area of Waller County.

In East Texas

Construction is under way on three gasoline plants in the Carthage field in East Texas. United Gas Pipe Line Company is building a 100,000,000-foot plant; Chicago Corporation, 125,000,000 feet, and Arkansas Fuel Oil Company 25,000,000 feet. Hydrocarbon Research, Inc., is again rumored as planning a Fischer-Tropsch type plant in this area to process 70,000,000 cubic feet. Rogers Lacy and Lone Star Producing Company are moving a cycling plant from Willow Springs deep area on the east side of East Texas field, to Carthage, with plans for processing 60,000,000 cubic feet of gas daily and returning 40,000,000 of it to formation.

In the Chapel Hill area, Smith County, Lone Star Producing Company is advancing plans for a 50,000,000-foot cycling plant. Gas for this plant will be from Paluxy wet gas sand and a limited amount from oil wells in the Rodessa zone, all of the residue to go into the Paluxy zone.

In Gregg County, East Texas field, Sinclair Prairie Oil Company is increasing facilities at its Plant 18 to strip 4,000,000 cubic feet daily now being flared.

Charles A. Schwartz and associates are building a gasoline plant in the Quitman field to process 1,500,000 cubic feet of gas daily.

West Texas

In West Texas, Phillips Petroleum Company is increasing its gasoline plant in the Fullerton field, Andrews County, from 15,000,000 to 22,000,000 cubic feet daily. The additional gas is to come from oil wells now flaring the gas. About half of the residue is to go to Cabot Carbon Company for black.

Shell Oil Company has plans for a gasoline plant in the TXL field, to process 30,000,000 cubic feet from oil wells, the residue to be available for transmission. In the Keystone field, Winkler County, Gulf Oil Corporation has plans for a plant, details not yet released.

Texas Panhandle

Several companies are stepping up the capacity of plants in Panhandle fields.

Texoma Natural Gasoline Company is increasing its Stinnett plant, Moore County, by 80,000,000 cubic feet daily.

Also in Moore County, Phillips Petroleum Company recently completed an addition to its Sneed plant. This company is preparing to increase its Hansford County plant, on the Texas side of the Hugoton field, from 83,000,000 to 133,000,000 cubic feet daily.

Skelly Oil Company and Cities Service Oil Company are near completion on a high-pressure plant in the Pampa-Kingsmill field, Gray County. They will repressure oil producing formations in the West Pampa field with 7,000,000 cubic feet of gas daily. Additional construction is also planned in this area by these operators.

Southwest Texas

In Southwest Texas, Sinclair Refining Company is preparing to pipe gas from the East White Point field, San Patricio County, to its refinery at Corpus Christi

DELIVERY . . . NIGHT AND DAY . . . .

can depend on

When you need supplies, you want to deal with men who know your problems; who have the experience and the lines of equipment to give you the things you need; who will get them in your hands quickly.

For thirty-five years we have specialized in oil industry equipment in the Mid-Continent and Gulf Coast areas. We realize that there is no business on earth where service means more than in the oil industry. The proved, nationally-known lines that we carry, and the reliable service we offer are your assurance that when you call the Norvell-Wilder man, you'll get the right equipment at the right time. Call us, for better selection and quick delivery.

A FEW OF THE WELL KNOWN LINES AVAILABLE TO YOU AT OUR STORES

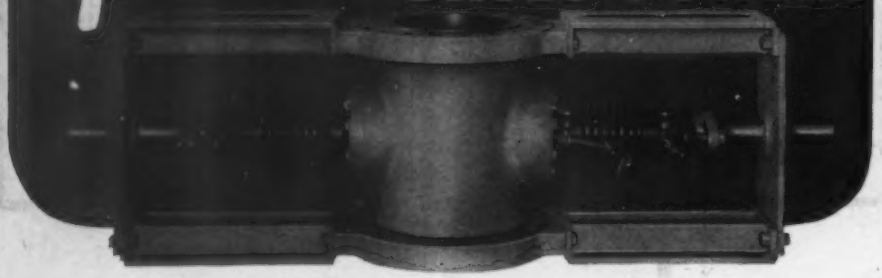
Babcock and Wilcox	Still, Condenser Tubes
A. M. Byers Company	Wrought Iron Pipe
Chaplin Fulton Company	Regulators
Dean Brothers Pumps, Inc.	Pumps
Hewitt Rubber Corp.	Packing, Hose
Hughes Tool Company	Valves
Kennedy Valve Mfg. Co.	Valves, Fittings
Ladish Drop Forge Company	Flanges, Forgings
A. Leschen & Sons Rope Company	Wire Rope
The Lunkenheimer Company	Valves, Steam Specialties
Merco Nordstrom Valve Company	Plug Valves
Pittsburgh Steel Company	Stainless Tubes, Still Tubes, Carbon, Moly Pipe
Quigley Company	Refractories, Insulation Material
Reed Roller Bit Company	Valves
Republic Steel Company	Line Pipe, Condenser Tubes
Strong, Carlisle & Hammond	Traps
Tube Turns, Inc.	Tube Turns, Flanges
Watson Stillman Company	Forged Steel Fittings
Victaulic Company of America	Couplings

WILDER

COMPANY

IN NEW YORK, SAN FRANCISCO, BUFFALO, OR NEW ORLEANS

Quick Action SAVES POWER!



NO. 641—600-pound valve equipped with double-end shaft and dual finned stuffing boxes for super-heated steam at 540 psi.

• • • •

The opening or closing time of the vane in an R-S Butterfly Valve varies from one second to an interval of several minutes. Such quick or slow action, coupled with the natural low head loss due to the valve design, provides wide adaptability in the handling of a multitude of materials and a considerable saving in power on pumping operations.

The R-S Butterfly Valve offers *simplified* control and shut-off of volume and pressure. Adapted to elevated or sub-zero temperatures. 15 to 900 psi. Telephone the R-S District Engineer for quick action.

DISTRICT ENGINEERS

Appleton, Wis.
POST POWER SUPPLY CO.
P. O. Box 544
Wis. 2635

Atlanta 3, Ga.
C. E. JOHNSON & ASSOCIATE
Bona Allen Bldg.
Walnut 2632

Baltimore 18, Md.
KONE ENGINEERING CO.
11 W. 25th St.
Belmont 6200

Boston 10, Mass.
W. B. PARSONS CO.
10 High St.
HUBrd 4119

Charlotte 2, N. C.
LYDON-COUSART COMPANY
304 Builders Bldg.
3-4481

Chattanooga 2, Tenn.
EDGAR A. ROGERS
Chattanooga Bank Bldg.
7-4640

Chicago 4, Ill.
W. P. NEVINS CO.
53 W. Jackson Blvd.
Harrison 1473

Cincinnati 2, Ohio
H. T. PORTER CO.
1413 Union Central Bldg.
Main 1299

Cleveland 13, Ohio
ASHMEAD-DANKS CO.
Rockefeller Bldg.
Main 6192

Des Moines 9, Iowa
PRODUCTS, INC.
420 Paramount Bldg.
3-5156

Detroit 4, Mich.
SPURGEON COMPANY
5050 Joy Road
Tyler 7-2750

Houston 2, Texas
POWER SPECIALTY CO.
1536 Mellie Esperson Bldg.
Preston 5384

Indianapolis 4, Ind.
POWERPLANT EFFICIENCY CO.
Union Title Bldg.
Market 4617

Kenmore 17, N. Y.
R. W. CRANE
37 Parkwood
DWLawr 8141

Los Angeles 15, Calif.
BUSHNELL CONTROLS & EQUIPMENT CO.
117 W. 9th St.
Vandike 1359

Milwaukee, Wis.
T. E. HILGENBERG
2307 N. 28th St.
Kilbourn 0345

Minneapolis 2, Minn.
GEO. R. MELLEMA
1024 Plymouth Bldg.
Main 6597

New Orleans 12, La.
JOHN H. CARTER CO.
1013 Canal Bldg.
Magnolia 1847

New York City 17
F. H. YOCUM-A. H. GOODE
Graybar Bldg.
Murray Hill 5-3370

Philadelphia 44, Pa.
FLUID CONTROLS CO.
18 West Chelten Ave.
Tenn. 0220

Pittsburgh 22, Pa.
J. F. HALLOWELL
Columbia Bldg.
Court 5362

Richmond, Va.
C. E. JOHNSON & ASSOCIATE
1107 American Bldg.
3-4810

Rochester 4, N. Y.
GEO. VAN VECHTEN
217 East Avenue
Stone 4164

St. Louis 3, Mo.
RUSSELL PATTON
3020 Olive St.
Franklin 2836

San Antonio 5, Texas
POWER SPECIALTY CO.
923 Milan Bldg.
Fannin 7384

San Francisco 4, Calif.
BUSHNELL CONTROLS & EQUIPMENT CO.
Mills Tower, 220 Bush St.
Exbrook 1102

Seattle 1, Wash.
M. N. MUSGRAVE & COMPANY
2019 Third Avenue
Eliot 4425

Tulsa 4, Okla.
DOUGLAS FRAZIER
1524 So. Gary Place
6-0384

Washington 5, D. C.
A. BURKS SUMMERS & ASSOCIATES
411 Colorado Bldg.
14th & G Sts., N.W.
Republic 7231

Wausau, Wis.
POST POWER SUPPLY CO.
920 Grand Ave.
3458

EXPORT SALES
R. S. Products Corporation
411 Colorado Bldg.
14th & G Sts., N.W.
Washington 5, D. C.

VALVE DIVISION R-S PRODUCTS CORPORATION
120 Berkley Street • Philadelphia 44, Pa.

R-S Streamlined BUTTERFLY VALVES

to be used as fuel. This will utilize about 4,500,000 cubic feet now being flared.

La Gloria Corporation is installing a large extension to its cycling plant in the La Gloria field, Jim Wells County.

In the Agua Dulce-Stratton area, Nueces County, Chicago Corporation is installing a second plant to take 10,000,000 cubic feet daily from oil wells which previously was flared. This area has three recycling plants. Southern Minerals Corporation recently completed an extraction plant which is utilizing gas from oil wells.

Barnsdall Oil Company is constructing a gathering system and compressor plant in the Placedo field, Victoria County, The capacity will be 7,000,000 cubic feet daily with the gas being turned into lines of the Tennessee Gas and Transmission Company.

In the Rincon field, Starr County, Continental Oil Company and Rice Institute are constructing a pressure maintenance plant which will be in operation within a few weeks.

Plans are also being outlined by interested operators for the construction of a recycling plant in the North Pettus-Burnell area of Bee County.

Gasoline Production Company is installing a recycling plant in Bee County to serve the Ray, South Mineral, and West Tulita fields.

Other Areas

El Paso Natural Gas Company is installing facilities at its Jal 2 gasoline plant in Lea County, New Mexico, to compress 7,000,000 cubic feet daily of residue gas, now being flared, for delivery into its transmission line.

In Louisiana. The California Company and the Carter Oil Company are outlining plans for a cycling plant in the Lake St. John field. Haynesville Operators Committee is increasing the capacity of its plant at Haynesville from 16,000,000 cubic feet daily to 22,000,000 cubic feet daily.

Anchor Gasoline Corporation is installing additional compressors at its plant in the Cheneyville field, Avoyelles Parish, to increase its take from oil wells by 6,000,000 cubic feet daily.

The Texas Company has completed an addition to its cycling plant in the Bateman Lake field, St. Mary's Parish.

Continental Oil Company also is extending its pressure-maintenance system in the Ville Platte field, Evangeline Parish.

Rogers Lacy Building Refinery in Mississippi

Rogers Lacy of Longview, Texas, has started construction of an oil refinery at Haney, Mississippi. First such plant in the state, it will have a daily capacity of 3500 barrels daily and is scheduled for operation within four months.

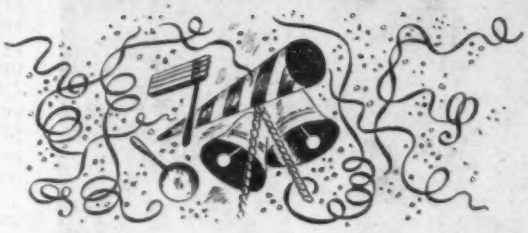
Company Formed to Build Pipe Line in Arabia

Trans-Arabian Pipe Line Company of Delaware has been organized by The Texas Company and Standard Oil Company of California, with plans to build a pipe line from the Persian Gulf to the Mediterranean. Negotiations for right-of-way are underway, and actual construction will await a more favorable period as concerns materials and labor.

The two companies jointly own Arabian American Oil Company which has production and refining facilities in Arabia, including a new 50,000-barrel

it's Post War now

For Mathieson's Sodium Chlorite and its Co-Product, Chlorine Dioxide



YES — through the ingenuity of Mathieson's chemical engineers, the available supply of Sodium Chlorite (and its amazingly useful co-product, Chlorine Dioxide) has been stepped-up to totals almost as great as originally planned for post war!

In simplest terms, this means that this most versatile — *under certain conditions most powerful and under other specific conditions most gentle* — oxidizing agent yet developed is available *now*. To many phases of American industry and to hundreds of communities beset with taste and odor problems in their water supply systems — this announcement will be of outstanding significance.

The adoption of Sodium Chlorite and Chlorine Dioxide in the technique of bleaching is certain to result in improved quality of many products now bleached by older methods. Textiles — cotton, rayon, and nylon . . . paper products of all kinds . . . edible and inedible oils . . . shellacs and varnishes . . . even beeswax and straw products, can be bleached *whiter* than ever before with an absolute minimum change of chemical and physical characteristics through the use of Sodium Chlorite. And Mathieson's research staff is still developing more and more uses for this greatest of oxidizing agents!

Mathieson is prepared to furnish full information on Sodium Chlorite — and Mathieson's staff is ready to work with you now in adapting this outstanding chemical to your requirements. Write today!

THE MATHIESON ALKALI WORKS (INC.) • 60 East 42nd Street, New York 17, N.Y.

SODIUM CHLORITE . . . CHLORINE DIOXIDE . . . HTH PRODUCTS . . . LIQUID CHLORINE . . . SODIUM METHYLATE . . . CAUSTIC SODA . . . SODA ASH . . . BICARBONATE OF SODA . . . FUSED ALKALI PRODUCTS . . . AMMONIA, ANHYDROUS & AQUA . . . SYNTHETIC SALT CAKE . . . DRY ICE . . . CARBONIC GAS

Mathieson
CHEMICALS

Setting a pattern for
STANDARD PROCEDURE

In a constant effort to improve procedures in welding and fabrication Associated has introduced methods which later received wide adaptation. Most recent Associated innovation is a portable, pre-heating, stress-relieving unit (pictured above) designed specifically for field operation. Associated sets the pattern for progress in piping.

ASSOCIATED PIPING & ENGINEERING CO., Inc.
2332 East 38th Street • Los Angeles 11, California

ASSOCIATED Progressive PIPING

plant nearing completion at Ras Tanura on the Persian Gulf.

Arabian American Oil Company recently reelected its officers and directors, including H. D. Collier, chairman, W. S. S. Rodgers, vice chairman, F. A. Davis, president, J. T. Duce, J. MacPherson and A. M. Martin, vice presidents, J. H. McDonald, secretary-treasurer, and H. D. Klein, A. N. Kemp, C. E. Olmsted and J. M. MacGaregil, directors.

Sinclair Announces Direct Amination Process

Sinclair Refining Company has developed a new method for the production of organic nitrogen compounds by direct amination of olefins. For example, ethylene and propylene, available in refinery gas or derivable from propane, are reacted with ammonia to produce nitriles and amines. E. W. Isom, vice president directing the research and development department, announces the process and cites United States patents numbered 2,381,470, 2,381,471, 2,381,472, 2,381,473 and 2,381,709 which were issued on August 7. Numerous other applications for patents which describe new chemicals and processes are pending.

The new process accomplishes organic nitrogen fixation by a catalytic reaction of ammonia with components of refinery gases which are now used for fuel; the direct amination employs the lowest cost sources of both reactive nitrogen and carbon compounds. Acetonitrile, propionitrile and butyronitrile are the primary products from ethylene and propylene. Pilot-plant operation has established the production of these compounds and many derivatives as pure chemicals.

Acetonitrile, acrylonitrile and ethyl, isopropyl and normal butyl amines are examples of known industrial chemicals which can be manufactured economically by the new process. Acrylonitrile is produced now for polymerization with butadiene to yield oil-resistant rubbers. Many new polymers and industrial syntheses are expected as soon as acrylonitrile can be produced more economically. Amines are required for rubber chemicals and other important syntheses, and a greater development is probable when this important class of organic bases are more extensively available.

Propionitrile, butyronitrile, normal propyl amines and isobutylamines potentially are new industrial chemicals. A market survey is now being conducted by Harshaw Chemical Company as distributing agents for information and samples. Numerous chemicals which have not been available previously for industrial use and many new derivatives hold great promise for future developments of pharmaceuticals, insecticides, fungicides, bactericides, solvents, intermediates for dyes, rubber, photography, and plasticizers, and synthesis of new rubbers, resins and plastics.

Harris General Manager Calumet Refining Company

Carl A. Harris has been elected a director and general manager of Calumet Refining Company, Chicago. He replaces A. J. Smith who recently resigned.

Harris has been with the organization 22 years, and recently was manager of the refinery at Burnham, Illinois.

THE MONTH IN THE INDUSTRY

END of the shooting in the Pacific came with such suddenness it found the oil industry with its nether extremities exposed, but not so far out of its pants as some other industries, judging from the turmoil and dire predictions of the travail of reconversion coming from spokesmen of industry geared for war, and from politicos who are oracles on unemployment and national calamity.

The oil industry will cut back with the rest, but currently only about as much as it has been complaining it has been over-straining its resources and capacity.

The industry's manpower, according to many in position to speak with authority, will not be laid off, and prospects are it will need even more personnel than its army of workers expected soon to return from the armed services.

Taking the lead in getting back to peacetime basis, Petroleum Administration for War began giving up its controls faster than the Japs could surrender. First came abolition of gasoline and fuel-oil rationing, followed by a long list of restrictions on materials, products and practices, so that by the first of September practically all regulation was removed, except material-inventory regulations imposed by the War Production Board. PAW expects to go out of business by the end of the year.

Cancellation of war contracts for fuel and lubricants accompanied lifting of civilian rationing, and a limited number of plants built with government funds to manufacture aviation gasoline or special products started closing down. Bulk of the war-built plants, however, were privately financed and their "reconversion" consisted of applying their new equipment to supplying better-than-before-the-war products for the civilian. Meantime the armed services will continue as important customers, although much dependence will be put upon their stocks.

Crude runs to stills, at 5,140,000 barrels daily, were at an all-time high during the week ending August 18. Crude stocks were at the lowest point since December, 1921, and crude oil production at 4,934,000 barrels daily was only 10,000 barrels below its peak of four weeks before. Refiners cut back 209,000 barrels daily during the next week, and increased production of gasoline slightly while doing so, but gasoline storage dropped 1,292,000 barrels. Fuel oils showed slight increases during the week.

For the week ending September 1, crude oil production held steady at 4,875,500 barrels daily; runs to stills were 4,685,000 barrels, or 455,000 barrels below the peak; gasoline stocks were 84,518,000 barrels daily, and fuel stocks continued their seasonal climb.

PAW has "recommended a cut-back of 238,000 barrels daily crude oil output during September, and it was indicated state authorities might order total cuts greater than that figure.

OPA officials are concerned with the prospects of the industry unless prices are controlled and subsidies are continued. However, premium payments on shipments are being abolished so that unnatural movements will cease.

Maston Nixon, president of Texas Mid-Continent Oil and Gas Association, came out with a declaration that the price of gasoline to the consumer should be increased one cent per gallon, and other products in proportion, to support an increase of 35 cents per barrel in the price of crude oil. "The independent producer will be wiped out in the immediate postwar adjustment unless he gets relief at once," Nixon said.

Future of the Big-Inch pipe lines will be a matter for congressional action. Either the lines or the tankers they were built to relieve will be surplus as oil carriers. Meantime the atomic bomb blasted agitation for an oil line from Texas to California.

Ethyl Corporation proposes its licensees in the United States shall increase premium gasoline specifications to a minimum of 78 octane by the time of the next contract period, November 15. Many refiners already have increased to that figure or better. However, it generally is believed there will be an "octane war" for the reason that cars now on the road would benefit little, if any, by having a higher grade fuel as regards octane than was common in 1941.

Gas industry spokesmen against federal restraint of its activities see in atomic power an argument that restriction of end-use of gas now is outmoded. This argument will be pressed before pending hearings before the Federal Power Commission. The industry figures that within the 50 years for which there are known gas reserves, atomic energy will have been developed to the point that common fuels will be obsolete. However, current construction of facilities and plans call for economical use of much gas now being wasted. Also elaborate plans for research on better use of present fuels and development of conventional substitutes are progressing.

API Tentatively to Meet in November

THE American Petroleum Institute has tentatively scheduled its war-delayed silver jubilee meeting, which also becomes the victory-celebration meeting, for November 12-15, at the Stevens Hotel, Chicago. Plans are contingent upon lifting of travel restrictions by that time.

Announcement by the institute emphasized that this meeting would be largely devoted to studies of new markets and new technologies of the petroleum and natural gas industries.

Standard Oil Development Company Building Two Super Research Labs

Standard Oil Development Company has let initial contracts for construction of two major petroleum research centers, at Linden, New Jersey, and Baton Rouge, Louisiana. The company already has large laboratories at each of those points. Work is to be speeded as the materials situation permits, in anticipation of completion late in 1946 or early 1947. Expenditures on these facilities ultimately will reach $8,000,000, it was made known by Eugene Holman, president of Standard Oil Company (New Jersey), who made the announcement, adding that "the program will provide scientists of the central technical organization of the Jersey Standard group with the most modern and extensive research facilities in the oil industry."

An increase of at least 20 percent in the present research and technical group of 2100 will be necessary, it was said.

R. P. Russell, president of Standard Oil Development Company, said the new laboratories would be used not only for developing improved products from oil and processes for producing them but in addition extensive work on extending sources of supply of oil products would be carried out. This latter work will include production of liquid hydrocarbons from natural gas, gasification of coal, oil from coal and production of oil from other carbonaceous deposits such as oil shale.

Basic studies will also be conducted on the application of catalytic processes to derive chemical raw materials from petroleum. One section of the new structures will be devoted to research on extremely low-temperature polymerization.

Russell said the company will expand its investigations in various aspects of the science of physics. Having had a part in the earlier work on the atomic bomb, it plans to keep abreast of developments involving use of atomic energy.

"We believe that these great research facilities can be an important factor in keeping the American oil industry the leader in fuels, lubricants and production of chemicals from oil and gas," Russell stated. "All practical discoveries flowing from this work will be made available to the entire industry in accord with the policy we have followed for many years.

"Everyone knows the mighty job the oil industry performed during the war in the perfection of high-octane aviation gasoline, synthetic rubber, synthetic toluene for TNT and such weapons as the jellied gasoline fire bombs, flamethrowers and the smoke generator. Jersey Standard hopes now to do a similar job in scientific research for peacetime products."

Keystone of the development at Linden will be a research center that will occupy 200,000 square feet. Nearby will be constructed a separate enginering building, a motor-test laboratory, a modern pilot-plant structure for carrying on

larger-scale investigations of petroleum processes, and several smaller buildings.

In addition to scientific equipment, the main building will house probably the most extensive petroleum technical library in the world. Anticipating its use by educators, students and other business men, the library will contain numerous private study chambers in a large hall two stories deep.

Indiana Standard Plans Expansion of Engineering

Plans for the establishment of an engineering research department and for expansion and reorganization of present engineering activities were announced early in August by Standard Oil Company (Indiana). George W. Watts has been named director of engineering of the manufacturing department, and D. A. Monro, chief designing engineer of the department. Under the new plans Watts will be in charge of all engineering work in the manufacturing department but will devote his time principally to the activities of the engineering-research department. All other engineering activities will be under the direct charge of Monro.

P. L. Krauel has been appointed chief engineer of the engineering division, Whiting refinery, where the company's largest engineering unit is located. Krauel will serve as the administrative head of the division which has been enlarged to include six departments, each to be headed by an assistant chief engineer.

The oil design department will be supervised by W. G. Guild, acting assistant chief engineer. A. T. Milbrook, assistant chief engineer, will supervise the utility design department. W. K. Brown has been appointed acting assistant chief engineer in charge of the newly-created plant-engineering department. This department will handle engineering matters pertaining to construction, inspection and field engineering, and will furnish consulting services to the operating and design departments. C. E. Dyckman is made assistant chief engineer, estimating department, and will continue to direct and supervise the work of the estimating engineers. W. R. Burrows will be in charge of the newly-created engineering development department, with the title of assistant chief engineer. D. F. Purdy, assistant chief engineer, will continue to supervise the drafting department.

In discussing the new plans for increasing the scope of engineering activities, Dr. M. G. Paulus, vice president, explained that "the changes are being made to provide the company with engineering and design advantages which can be derived only through engineering research and a high-quality engineering organization staffed with the best talent that can be obtained. The engineering advances thereby made possible will be applied to expanding and improving the company's manufacturing facilities, as another step in conformity with its long-established policy of furnishing better products at lower cost."

Standard of Indiana Starts Work On Research Laboratory at Whiting

Standard Oil Company (Indiana) has started construction of a research plant on property recently purchased by the company at Hammond, Indiana, near the Whiting refinery, with which it will be connected by pipe lines.

Erection of the main administration building, general laboratories, and three pilot-plant buildings will proceed at once. An engine laboratory, a greenhouse for insecticide work, additional pilot-plant buildings, and other research facilities are scheduled for subsequent construction.

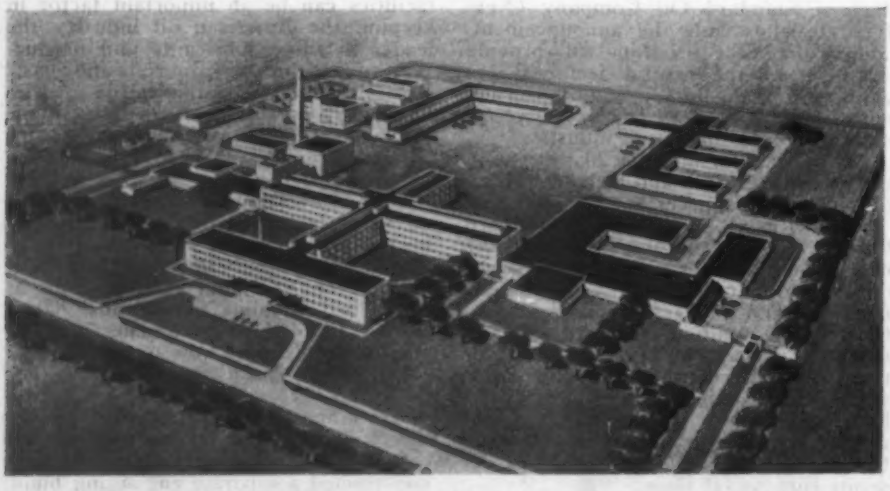
The principal buildings in the group will be of light-gray brick, in the modern type of architecture. They will be air conditioned throughout and lighted in accordance with the best modern practice.

The basic unit will be a two-man laboratory. A "mock-up" of such a unit, complete with furnishings and lighting was built and tried out by research department personnel prior to final approval of the architect's plans. Partitions will be removable so as to permit easy alterations to one-man laboratories or larger areas as may be desired. The width of a one-man unit is to be 11 feet. Since the main corridor will be off center, the laboratory lengths will be either 18 or 22 feet.

Two hundred of the company's technologists and 260 other research workers at present are housed in old and somewhat cramped quarters scattered through the Whiting plant. The new facilities will not only provide room for these workers to expand their activities and operate more efficiently, but also make possible a considerable increase in the company's total research activities.

One of the results will be availability of space for returning veterans without displacement of any of the present research staff. The company plans to take back 179 laboratory workers still with the armed forces without dismissing their replacements. Not all the research workers will be accommodated in the new plant, however, as the technical service group will continue in the refinery.

In addition to the work on improved fuels and lubricants, part of the research in the new laboratories will be in connection with the company's recently established chemical products department.



Architect's sketch of petroleum research laboratories under construction and planned by Standard Oil Company (Indiana) adjacent to the refinery at Whiting, Indiana.

NGAA Expanding High-Pressure Corrosion Research

Expansion of the research program to determine source of corrosion in high-pressure condensate wells has been broadened by the Natural Gasoline Association of America to include three studies at the University of Texas under direction of an NGAA Corrosion Research Project Committe. One project under the direction of Dr. Norman Hackerman will involve investigation of the physical types of surface layers and the correlation of the results with the types of corrosion observed in the wells; a second project, under supervision of Dr. H. L. Lachote, will be concerned with varieties and concentrations of organic acids and other compounds in waters taken from condensate wells; the third project, under the direction of Professor William A. Cunningham, includes routine analysis of water samples from both corrosive and non-corrosive wells from different producing horizons in dual-completion wells.

Battelle Memorial Institute was retained in 1944 to conduct fundamental research and laboratory experiments as outlined by the corrosion committee. This work is under the direction of Dr. H. A. Pray, who has made field trips to gain first-hand knowledge of problems involved. The work of the United States Bureau of Mines, conducted by C. Kenneth Eihlers, is similar to that of Battelle Memorial Institute, involving laboratory and field studies of corrosive materials, inhibitors, resistant alloys and phase distribution of water in flowing wells.

The Corrosion Committe of the American Petroleum Institute is headed by Frank S. West, West and Cole, Houston.

During the year investigation has disclosed that corrosive action involves more equipment than was anticipated. The problems now uncovered have been

HYDRODYNE VALVE ACTUATOR

S-M-O-O-T-H HYDRAULIC POWER ELIMINATES VALVE BOUNCE AND HAMMER-BLOW ACTION

The new Bendix Hydraulic Valve Actuators, which operate from electrical power sources, provide smooth, positive power for opening and closing valves.

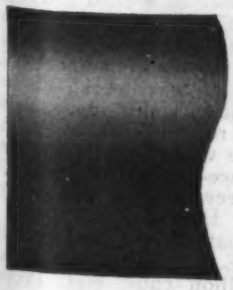
Through a simple hydraulic system, force is produced in a straight line through a cylinder to open and close the valve. As the valve seats, this pressure builds up to approximately 10 times the operating pressure, literally pressure-sealing the valve. The pressure is then locked in the cylinder and only the reverse action will unlock it. Due to this positive seating action it is impossible for the valve to "bounce" or leak. Should the pressure drop from any cause it is automatically re-established immediately. In addition, the unit is provided with a completely independent hydraulic system, using a hand pump, for emergency operation.

The inherent advantages of hydraulic operation provide two other outstanding characteristics: (1) the Hydrodyne Actuator is completely free from the "hammer-blow" action of other actuating devices, and (2) maintenance of this Bendix development has been reduced to routine inspection because the hydraulic oil serves as a lubricant for all moving parts.

A reversible electric motor of relatively small horsepower drives the oil pump in either direction to supply oil under pressure to actuate the valve. All electrical units are enclosed in explosion proof housings.

Hydrodyne Actuators are available for use on valves from 4" to 36" and can be applied to most types of valves. They can be set to actuate at speeds ranging from 12" per second to 6" per minute. Complete auxiliary indicating and regulating equipment can be provided.

☆ COMPLETE DATA ON BENDIX HYDRODYNE ACTUATORS IS INCLUDED IN CATALOG HVA-502 WHICH WE WILL GLADLY SEND TO RECOGNIZED COMPANIES ON REQUEST.



Pacific Division

Bendix Aviation Corporation

PRODUCT OF Bendix

Refiners:

Sell a QUALITY motor fuel Aimed at the QUALITY Peace-Time Market

MOTORISTS have been told by newspapers, magazines, the radio that major refiners are producing wonder gasolines for military use. They have been told that soon after the return of peace these improved motor fuels will be available for their cars. Peacetime motorists are going to expect . . . and will demand . . . fuels giving truly superior performance in automobiles, trucks, tractors, planes.

Now is the time to prepare to sell that quality peacetime market. And you need no new refining process . . . nor any multimillion dollar plant. Treat any regular gasoline with LUBRI-GAS. Because LUBRI-GAS cleans, lubricates and reduces friction in upper cylinder parts as it powers the motor, the result will be a QUALITY MOTOR FUEL . . . the kind peacetime motorists will demand.

You can start producing this QUALITY MOTOR FUEL right now. Treat your gasoline with LUBRI-GAS. Give your dealers the sales making punch packed into every gallon of a QUALITY MOTOR FUEL. Help them win new pleased customers . . . expand sales . . . increase profits. Get the jump on competition.

BEAT YOUR COMPETITION TO THE PUNCH!
MEET THESE MOTORISTS' DEMANDS TODAY!

1. Easier Starting
2. Quicker Acceleration
3. Smoother Running Motor
4. Longer Motor Life
5. More Miles Per Gallon
6. Fewer Repair Bills
7. Anti-Knock Performance

By treating your gasoline with LUBRI-GAS you will give your customers all these things. LUBRI-GAS is essentially 40 SAE lubricating oil processed with a detergent and other chemicals so that it mixes with the gasoline without mechanical agitation and enters the combustion chamber with the fuel as an atomized oil fog. LUBRI-GAS frees sticky rings, loosens carbon deposits, eliminates carbon knocks, prevents overheating, stops oil pumping and increases power. By reducing friction it cuts down wear and builds up mileage.

"Puts You Out in Front of All Competition"

For full particulars write, wire or phone TODAY to

LUBRI-GAS

221 North LaSalle Street
CHICAGO 1, ILLINOIS

THE MONTH . . .

described by T. S. Bacon, Lone Star Producing Company, Dallas, committee chairman, as:

"The necessity of finding a solution to the very destructive and expensive corrosion in wells of this type is so pressing that every possible avenue leading to that result is to be investigated. The apparent magnitude of the problem has expanded tremendously during the past year. Serious internal corrosion has been found in many new condensate producing areas. One operator has found it necessary to replace an entire string of tubing which had been seriously weakened by internal corrosion after only seven months of service. Some instances of casing failure have been reported that might be ascribed to this type of corrosion. Feld observations as reported a year ago showed corrosion of pipe and fittings to be confined largely to areas close to the wellhead, while during the past year observations clearly show this corrosion can start at the producing formation and continue through the flow lines to the plant."

Personnel of the NGAA Corrosion Research Project Committee includes T. S. Bacon, Lone Star Producing Company, Dallas, chairman; F. S. West, West and Cole, Houston; T. W. McGuire, Cotton Valley Operators Commitee, Cotton Valley, Louisiana; L. B. Wood, Phillips Petroleum Company, Bartlesville, and W. E. Winn, Sun Oil Company, Dallas.

Wellhead testing of alloys in the gas streams of corrosive wells is a project of National Association of Corrosion Engineers, under the direction of Walter F. Rogers, Gulf Oil Corporation, Houston.

Postwar Outlook Promising For Natural Gas Industry

The postwar outlook for the natural gas industry will be one of the brightest of industrial pictures, if the industry is allowed to follow its normal course of expansion without being overburdened with restrictive legislation that is not in the public interest, accordiing to R. H. Hargrove, chairman of the Natural Gas Department of American Gas Association, and vice president and general manager of United Gas Pipe Line Company.

The industry has been faced with an increasingly responsibility during the war emergency in supplying record quantities of gas for domestic, industrial and commercial uses, Hargrove said. The difficulties have not been due necessarily to the record quantities furnished but more to needed additional facilities and rearrangement of existing facilities to supply gas where it has been required most for industries directly engaged in war work. The industry never lacked faith in its ability to deliver the record quantity of gas required for the war effort. It will continue to produce and deliver the increased load necessary to supply postwar needs, Mr. Hargrove declared.

Reserves of natural gas were recently estimated by E. DeGolyer at approximately 200 trillion cubic feet. Proved reserves at the beginning of 1945 were more than 140 trillion cubic feet, based

CARBON HAS NO MELTING POINT!

CARBON, in all forms, volatilizes without melting at temperatures far above those encountered in commercial operations.

The use of large carbon blocks for blast furnace linings is an excellent example of carbon's extraordinary ability to retain its shape—*and strength under pressure*—at white hot temperatures. In addition, it is highly resistant to chemical attack by the most corrosive slags. Hence it has become the preferred material for many high temperature applications in the metallurgical and electrochemical fields.

Graphite's very low coefficient of thermal expansion—.0000015 per °F—explains why some graphite molds for ferrous and non-ferrous metals withstand several thousand pours without longitudinal or cross-sectional change. Graphite electronic tube components, at temperatures far exceeding operational requirements, maintain an unmatched degree of dimensional stability.

Furthermore, "National" Carbon and Graphite are available as porous materials or in the form of "Karbate" impervious products for the chemical industries. We invite your inquiries on the many applications and installations of these highly versatile materials of construction.

BAR OF WHAT?

Carbon, Graphite or "Karbate" materials, of course!

The words "National" and "Karbate" are registered trade-marks of National Carbon Company, Inc.

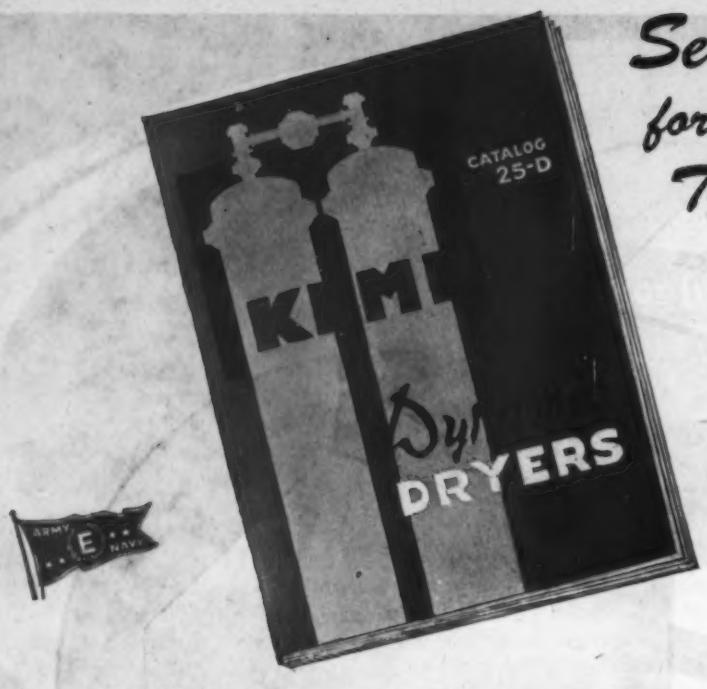
NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

General Offices: 30 East 42nd Street, New York 17, N. Y.

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco



Send for it Today!

You Need This:

Just off the press—this 44-page bulletin is a real contribution to engineering literature and should be in your files. It is an authoritative, well-illustrated treatise which makes clear (a) the mechanics of operation of dynamic adsorptive dehydrators (b) the characteristics which make solid adsorptive dessicants so efficient for the dehydration of air or gases, the drying of liquids, and for industrial control.

A wide variety of both standard and special units is also shown to illustrate how KEMP Dynamic Dryers can be profitably applied to your operations and processes.

THE C. M. KEMP MFG. CO.
405 E. Oliver Street, Baltimore 2, Md.

Please send me copy of new Catalog No. 25-D.

Name .....Title .....

Company .....

Street .....City.....State.....

KEMP PRODUCTS

Dynamic Dryers (adsorptive dehydrators) — Flame Arrestors for vapor lines, flares, etc.
Nitrogen Generators • Inert Gas Producers — The Industrial Carburetor for premixing gases
Atmos-Gas Producers • Immersion Heaters — Submerged Combustion Burners
A complete line of Industrial Burners, and Fire Checks.

Address The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Maryland

KEMP of BALTIMORE

THE MONTH...

on surveys of fields having reserves of more than 20 billion cubic feet, plus reserves of the Appalachian area. Making allowance for lesser fields and for probable expansion of discovered fields the estimated reserves of 200 trillion cubic feet are conservative. With estimated withdrawals at 4 trillion cubic feet for 1944, the ratio of reserves to present consumption is better than 35 to 1.

Hargrove said a recent breakdown of postwar expenditures made by the Federal Power Commission at the request of the American Gas Association, showed that the natural-gas industry will spend $160,898,000 for plant expansion, maintenance and inventories and supplies in the 12 months immediately following peace. Of this amount, approximately $120,000,000 would be spent on additional plant and equipment.

The Federal Power Commission estimated revenues from sales of natural gas to consumers for the 12 months ending May, 1946, would be $619,398,000. This figure does not take into account sales by natural gas companies to other utilities for generation and resale. Total revenues from the sale of natural gas for 1944, according to the American Gas Association's report, were $677,951,000. Sales by the industry for the 12 months ended May 31 last were nearly 8 percent ahead of the comparable period a year earlier and it is estimated that dollar sales for 1945 will cross the 700 million mark.

Important expansion in the natural-gas industry is of comparatively recent origin, he said. In 1900 sales amounted to 160,000 MCF and customers totaled 525,000. In 1935 the industry sold 1,064,233 MCF to 6,890,000 customers. The American Gas Association reported total sales of 2,189,392 MCF to 9,189,000 customers in 1944, and the trend in volume sales and customers served is still rising.

Looking to the possibility of extended markets, the industry has filed projects or has recently received approval of the Federal Power Commission for the construction of nearly 5,000 miles of additional natural gas pipe line in this country, capable of transmitting more than 400,000,000 additional cubic feet a day at peak movements.

West and Cole Gasoline-Cycling Plant Consultants

Frank S. West resigned August 15 as chief engineer in charge of gasoline- and cycling-plant design and construction for The Texas Company at Houston, to join H. S. Cole, Jr., formerly assistant to the manager of the production department of The Texas Company, in organizing West and Cole. This partnership will engage in gasoline- and cycling-plant design, and consulting engineering in the field of gas, natural gasoline, and condensate recovery.

West obtained an engineering degree at University of California in 1923, and was an engineer with General Petroleum Corporation and Union Oil Company of California before joining The Texas Company 17 years ago. In 1942 he was transferred to Houston as chief engineer in charge of gasoline- and cycling-plant design and construction, in

FRONTIER GAS
RARIN' TO GO
CONOCO
SOHIO X-70
Mobilgas
IMPERIAL PRODUCTS
SUPER PEPPER
CITIES SERVICE OILS
ONCE-ALWAYS
Phillips 66
PENNZOIL
Motor Oil
Great Names
in Gasoline and
Lubricating Oils
GO "ON STREAM" WITH
FILTROL
Catalysts and Adsorbents
Throughout America — in fact, throughout the whole world — wherever gasoline and lubricating oils are made you will find Filtrol Catalysts or Adsorbents played a vital part.
For Filtrol products have a proven commercial background—a record of performance and efficiency that justifies their overwhelming leadership.
Filtrol Catalysts for higher octane gasolines and Filtrol Adsorbents for better lube oils give maximum performance. Filtrol products are superior through chemically prepared, natural crystalline montmorillonite structure, making available scores of acres of internal adsorptive surface in every pound of Filtrol Catalysts and Adsorbents.
Write today for new booklets on Filtrol Catalysts or Filtrol Adsorbents.
FILTROL CORPORATION
General Offices: 634 S. Spring St., Los Angeles 14, Calif.
Plants: Vernon, California, and Jackson, Mississippi
Filtrol*
CATALYSTS and ADSORBENTS
Products of Filtrol Research and Development
*Reg. U. S. Pat. Off.
SHELL Premium
TEXACO
RICHFIELD HI OCTANE
THAT GOOD GULF GASOLINE
FLYING A
ASSOCIATED GASOLINE
LION PETROLEUM PRODUCTS
GOLDEN TIP GASOLINE
STANDARD GASOLINE
Autolene
B-A
MOTOR OIL
Esso EXTRA
PURE-PEP
Be sure with Pure
REPUBLIC
UNION PRODUCT 76 GASOLINE
DEEP-ROCK SUPER GASOLINE
SINCLAIR H-C GASOLINE
Protexol
MOTOR OIL
WILSHIRE POLLY GAS
BLUE SUNOCO

Interchangeable Parts

MEAN EASIER, LOWER COST VALVE MAINTENANCE

HERE'S HOW IT WORKS!

All parts of the valves shown here (except bodies and bonnet rings) fit each other perfectly. If, for example, you need a stem, disc, or seat ring for the "Renewo", you can use the corresponding part of the "Ferrenewo"—*it is exactly the same.* This means fewer parts to be carried, speedier repairs, and greater ease in making them.

Fig. 1031 150 lb. S. P. Iron Body "FERRENEWO" Regular Type

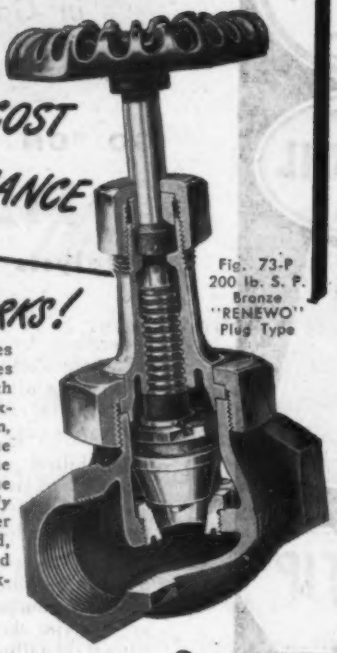
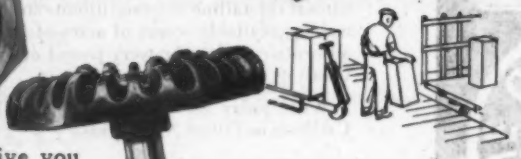


Fig. 73-P 200 lb. S. P. Bronze "RENEWO" Plug Type



● Maintenance men can give you a flock of reasons why they prefer LUNKENHEIMER quality-built Valves. Prominent among those reasons is the *wide* interchangeability of parts made possible by Lunkenheimer's highly developed simplicity of design and precision workmanship.

In the "Renewo" and "Ferrenewo" Valves, this interchangeability has long been of highest practical value to industry, in making valve maintenance easier, speeding production, lowering costs. And—vitally important today—*saving fuel* that comes from tight valves.

Lunkenheimer Distributors are located in the principal industrial centers. There is one near you. Call on him—you'll find him equipped with a COMPLETE STOCK of parts that will make Lunkenheimer "interchangeability" a time-saving, labor-saving, money-saving FACT in your plant!

Fig. 73 200 lb. S. P. Bronze "RENEWO" Regular Type

The Lunkenheimer Co., Cincinnati 14, Ohio, U. S. A. Branch Offices: New York 13, Chicago 6, Boston 10, Philadelphia 7. Export Department: 318-322 Hudson St., New York 13, N. Y.

LUNKENHEIMER VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S. P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

THE MONTH...

which capacity he has supervised several important installations.

Cole also is vice president of Thompson-Carr, Inc., drilling contractors, and the two companies have established offices at 3503 Montrose Boulevard, Houston.

Natural Gasoline Board Plans Meeting Next April

Natural Gasoline Association of America is going ahead with plans for an annual meeting in the Baker Hotel at Dallas on April 17-18-19, 1946.

These dates have been set by the board of directors of the association on the assumption that restrictions on travel and hotel accomodations will have been reduced by that time.

American Gas Association Annual Meeting October 24

The twenty-seventh annual meeting of American Gas association will be held October 24, at the auditorium of the Engineering Societies Building, 29 West 39th Street, New York. To impose a minimum burden on transportation and hotel accommodations, the association again will limit its yearly convention to a one-day meeting.

Officers will be elected at the general membership meeting in the morning and committee chairmen will read reports covering the activities of their sections during the past fiscal year. The luncheon meeting and the remainder of the day will be devoted to organizational work by departments and committees.

American Gas Association Gets New Managing Director

H. Carl Wolf has been elected managing director of American Gas Association, effective October 1, succeeding Alexander Forward who is retiring from active business after serving in that capacity since 1923.

Wolf, who has a master's degree in electrical engineering from University of Illinois, has spent all of his business career in the utility field. Currently he is president of Atlanta Gas Light Company. He has been a director of American Gas Association since 1941, and in 1942 was appointed chairman of the association's national advertising committee.

Great Lakes Buys Worth Plant at Blue Island

Great Lakes Petroleum Company, Chicago, has purchased Worth Refining Company's 4000-barrel refinery at Blue Island, Illinois. Operations of the plant will be continued with prospect of increasing capacity at a later date.

Instrument Educational Conference at Carnegie Tech

An educational conference on instrumentation sponsored by Carnegie Institute of Technology and The Instrument Society of America has been arranged for October 16, 17, and 18.

The program will be divided into two parts. The first part covers the require-

WHITLOCK DESIGN

MEANS

operating economy

Remember Benjamin Franklin's famous adage on economy: "A penny saved is a penny earned"? It is a good one to keep in mind when considering heat transfer equipment because the investment cost of the equipment, including interest and depreciation, and operating costs, must be considered critically in relation to the savings effected.

For over a half-century, one of the prime considerations in any Whitlock design has been the proper evaluation of the economic factors involved. Emphasis is laid on the economic approach temperature, i.e., the temperature difference between the hot and cold fluids which will return the greatest net profit.

This basic principle, implemented with technical experience and years of research, produces a properly engineered unit, which means maximum operating economy.

Send us your heat transfer problems.

WHITLOCK DESIGNS AND BUILDS

Bends	Heaters
Coils	Piping
Condensers	Pressure Vessels
Coolers	Receivers
Heat Exchangers	Reboilers

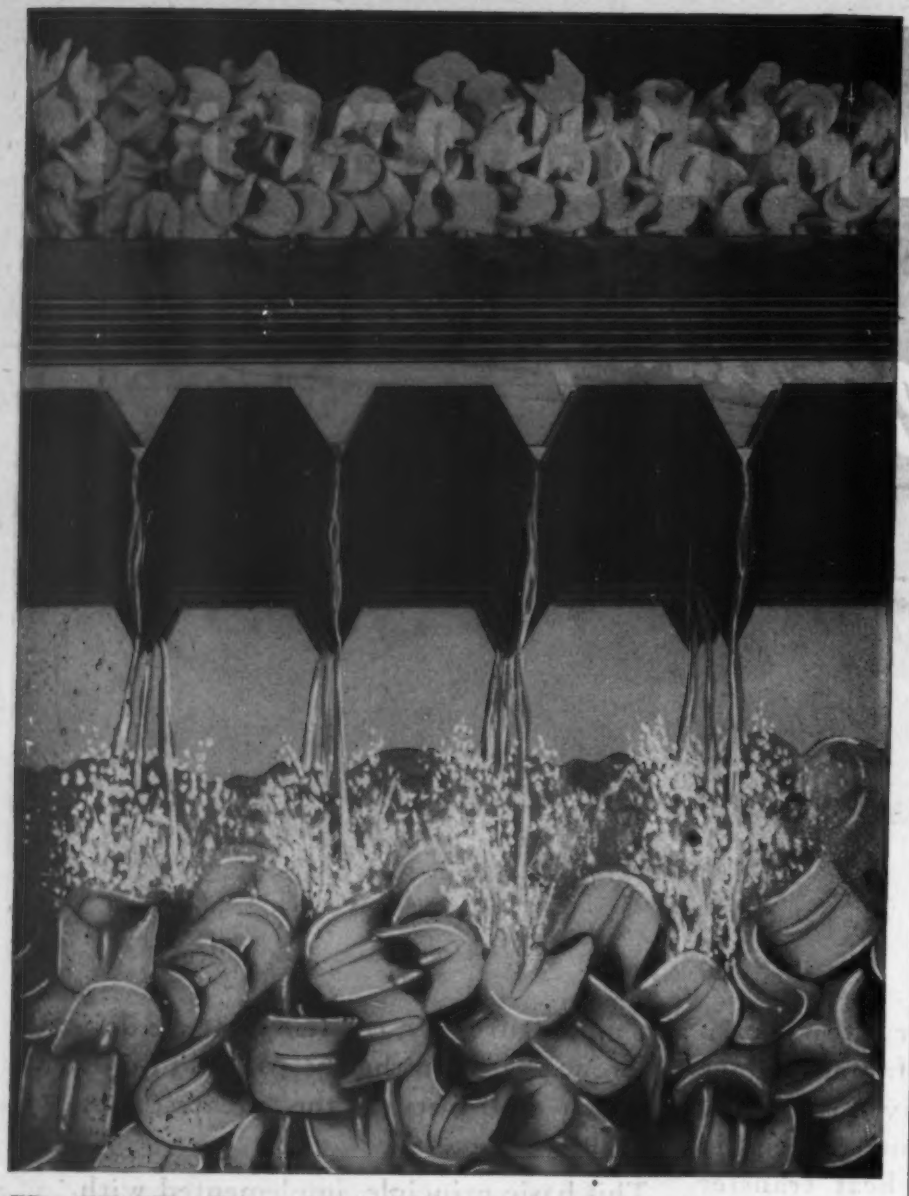
The* WHITLOCK *Manufacturing Co.

75 South St., Elmwood, Hartford 1, Conn.

NEW YORK · CHICAGO · BOSTON · PHILADELPHIA · DETROIT · RICHMOND

Authorized Representatives in other principal cities — In Canada: Darling Brothers Ltd., Montreal

ESTABLISHED 1891 - AHEAD OF THE TIMES FOR HALF A CENTURY



BERL SADDLES Provide
Maximum Capacity, Better Operation

Large effective surface area
Low resistance to flow
Wide angle distribution
Large open volume
Corrosion-proof

With Berl Saddles in your distillation columns, absorption towers, extraction columns or gas scrubbers, you are assured of maximum capacity and better operation. The illustration above shows heart of a fume washer with 1" Berl Saddles below and V-Weir type distributor. The ½" Berl Saddles above act as a mist eliminator. Berl Saddles are available in ½", 1" and 1½" sizes of chemical stoneware or porcelain material.

MAURICE A. KNIGHT, 809 Kelly Ave., Akron 9, Ohio

KNIGHT-WARE
CHEMICAL EQUIPMENT

THE MONTH...

ments expected by industries and the second part will be devoted to present training in instrumentation.

The chairman of the committee is Dr. B. R. Teare, Jr., head of the department of electrical engineering of Carnegie Institute of Technology, Pittsburgh 13. Due to traveling requirements, the conference is limited to 50 and invitations will be sent to those in the order in which applications for attendance are received. Such applications are to be made to Dr. Teare.

Neches Butadiene Plant Working at Capacity

Production of 52,000 tons of butadiene from petroleum in the first six months of this year was announced by Neches Butane Products Company, which is jointly operated by five oil companies for the government's synthetic rubber program. This is the rated capacity of the plant. If this production is applied to the manufacture of synthetic rubber tires for civilian passenger automobiles, it is estimated that 12,500,000 new tires will be available to the public.

Labor Bureau Issues Safety Bulletin on Ammonia

Division of Labor Standards, Department of Labor, Washington, has issued a bulletiin on ammonia, first of a series on controlling chemical hazards. Others shortly to be issued cover chlorine, sulphuric and nitric acids, formaldehyde, and the anilines. The series will include more than 100 bulletins, distribution being free for as many as 25 copies and special low prices for larger quantities.

Designed to aid safe handling, each bulletin describes the hazard of the chemical, its characteristics, safety precautions for installations, handling and storage, protective clothing, hazardous concentrations, and first-aid treatment. Each bulletin is checked for technical accuracy with manufacturers through the Manufacturing Chemists Association. A bibliography is included.

Navy Operates Profitable Fuel-Oil Reclaiming Plant

More than 5,000,000 gallons of fuel oil has been salvaged by the Navy during the past two years from sludges accumulated at the Norfolk Naval Operating Base.

A fuel-oil reclaiming plant at Craney Island, in the Elizabeth River off Norfolk, is processing sludges from ships and tankers and waste oil accumulated at various activities in the Norfolk Naval Supply Depot.

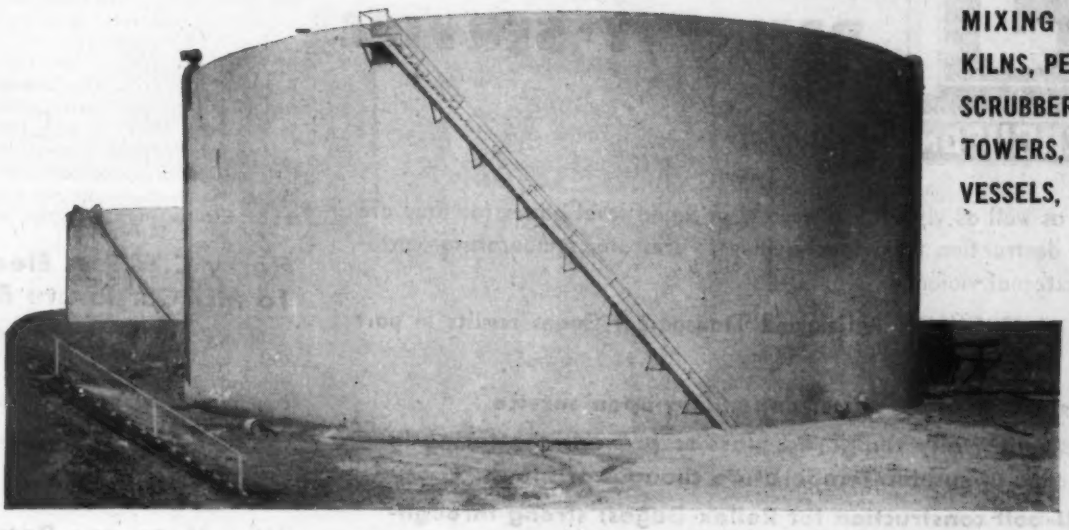
A Navy Department release explained that the plant had to be built when, at the outbreak of the war, it became necessary to stop dumping sludge at sea, because the resulting slick could reveal a ship's position to a lurking submarine, and also, but less importantly as compared with military necessities, because the shortage of oil demanded that every effort be made to conserve the supply.

The plant, established in May, 1943, consists of a gravity water-oil separator and pump house, a battery of

GATX GENERAL AMERICAN CAN designs and builds

TO HELP SOLVE YOUR PROBLEMS

PRESSURE VESSELS, STORAGE TANKS, WELDMENTS, ABSORBERS, ACCUMULATORS, AIR RECEIVERS, AUTOCLAVES, CREOSOTING CYLINDERS, MIXING KETTLES, KILNS, PENSTOCKS, SCRUBBERS, STILLS, TOWERS, VACUUM VESSELS, ETC.



The Plate and Welding Division at Sharon, Pa., is thoroughly equipped to fabricate every sort of plate-work, from any metal, by either riveting or welding. Facilities include complete X-ray, heat-treating and stress-relieving equipment, and an experienced Erection Department for foreign and domestic work.

PORTATION CORPORATION

PLATE AND WELDING DIVISION

530 Graybar Building, New York 17, New York

Chicago, Sharon, Louisville, Cleveland, Pittsburgh, St. Louis, Salt Lake City, San Francisco, Tampa, Washington, D. C.

Sharon, Pennsylvania, and Louisville, Kentucky

GAGES *for* REFINERY SERVICE

JERGUSON

Durability as well as visibility is needed in liquid level gages for they are subject to destruction from four elements: pressure, temperature, corrosion and external violence.

Durability of JERGUSON Reflex and Transparent Gages results in part from:

a . . . steel or alloy parts, depending upon service

b . . . scientifically tempered glass to prevent shattering in case of sudden temperature changes or blows

c . . . U-bolt construction for Reflex Gages; strong through-bolt construction for Transparent Gages

d . . . mica-protected glass for use with steam

Standard JERGUSON Gages are designed in Reflex Types for use under pressure up to 3200 pounds at 100° F. or up to 1200 pounds at 1000° F. In the Transparent Type they are designed for pressures up to 2000 pounds at 100° F. and up to 600 pounds at 1000° F. Special gages are available for more severe services. Also jacketed gages.

JERGUSON GAGE & VALVE CO.

87 FELLSWAY SOMERVILLE 45, MASS.

List of Representatives—Jerguson Gage & Valve Co.

H. R. Bowers Co.
721 Leader Building
Cleveland 14, Ohio

Bushnell Controls & Equipment Co.
117 West Ninth Street
Los Angeles, California
and
220 Bush Street
San Francisco, California

Desco Corporation
Second & Welsh Streets
Chester, Penna.

W. D. Emery Co.
426 McBirney Building
Tulsa, Oklahoma

Arthur Forsythe Company
500 First Ave., South
Seattle, Washington
and
921 S. W. Oak Street
Portland, Oregon

Mr. J. Arthur Moore
342 Madison Avenue
New York 17, N. Y.

O'Brien Equipment Co.
2832 Olive Street
St. Louis, Mo.

Daniel Orifice Fitting Co.
P. O. Box 2512
Houston 1, Texas

Peacock Brothers Limited
P. O. Box 6070
Montreal, Quebec, Canada

Smith Instrument & Equipment Co.
1900 East Jefferson Avenue
Detroit, Michigan

Associated Valve & Engineering Co.
510 North Dearborn Street
Chicago, Illinois

9-JV-4

THE MONTH . . .

four steam heaters, two settling tanks and two cooking tanks. Intially, the oil was separated from the water by a skimming process, but this left an emulsion which could neither be broken down further at the time nor burned. It was not until April, 1944, that a petroleum liaison group tackled the problem and came up with chemical formulas for the treatment of two different types of emulsions which did the trick.

Oil valued at from $1.35 to $2.65 per barrel is now being reclaimed at a cost of 6 cents a barrel, exclusive of labor and overhead, the department said.

British American Acquires Union Properties in Canada

The British American Oil Company has acquired the business and physical assets of Union Oil Company of Canada, including marine terminals at Vancouver. The purchaser thus extends its marketing activities throughout the Dominion. The company announced it does not contemplate construction of a refinery on the West Coast, but will secure its supplies from Union Oil Company of California, products for its eastern territory to continue to come from its five refining plants in the latter area.

Harry C. Wiess Elected To MIT Corporate Board

Harry C. Wiess, president of Humble Oil & Refining Company, has been elected a special-term member of the corporation board of Massachusetts Institute of Technology. He succeeds Edward R. Stettinius. Wiess is a graduate of Princeton University, and is a trustee of The Rice Institute.

War Veterans Returning To Jersey Standard

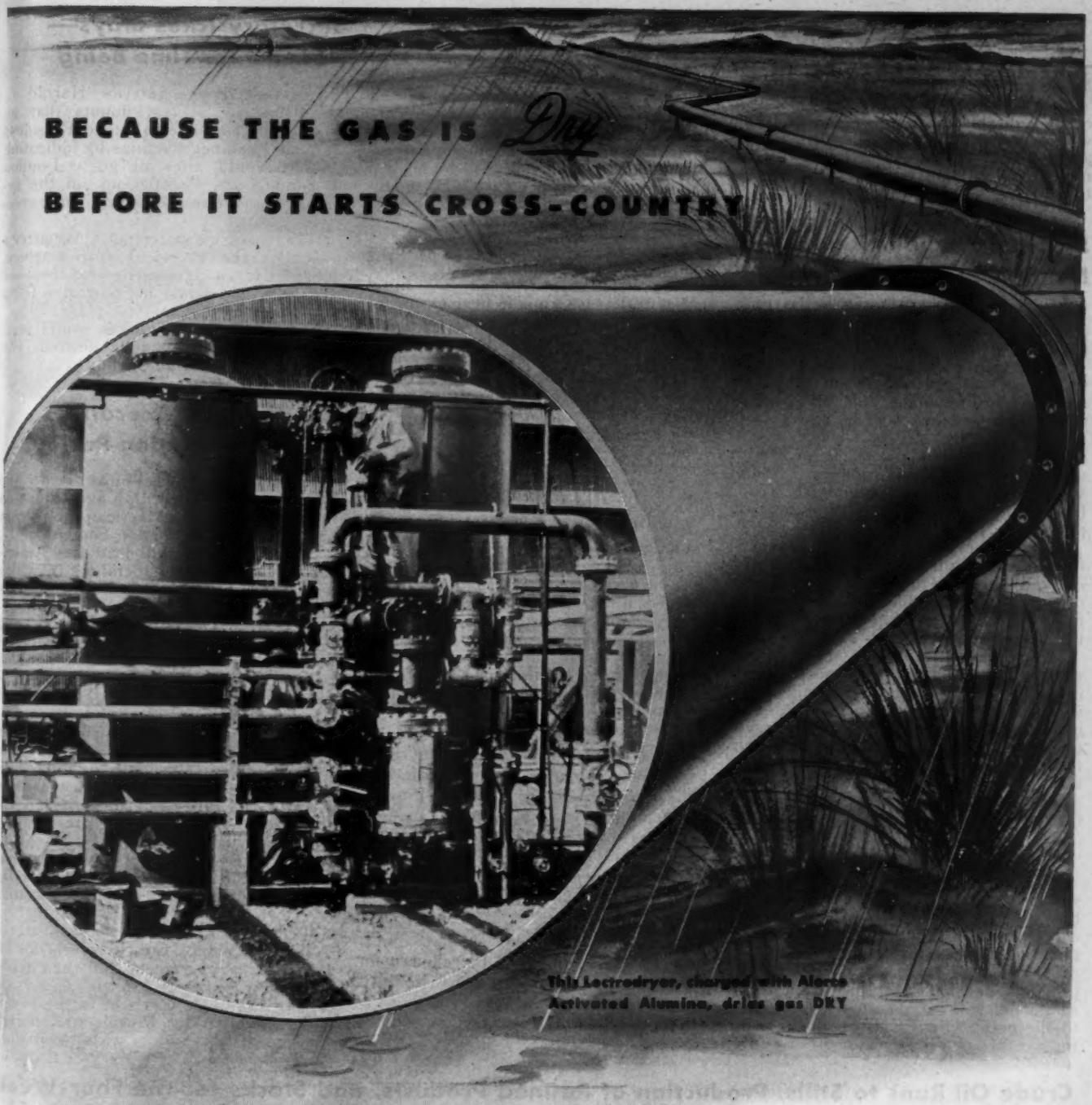
More than 93 percent of its employes discharged from the Armed Services have returned to work for Standard Oil Company (New Jersey) and its affiliates, Frank W. Pierce, director, revealed.

In addition, the company has hired approximately 2,000 returned veterans who were not previously employed by it.

"One out of every seven Jersey Standard employes went away to war, a total of more than 8,000" Mr. Pierce said. "Nearly a fifth have been discharged from the services, and we feel particularly gratified that such an overwhelming percentage of this number have come back with us."

In each case of a returning veteran, Pierce said, either his old job or another comparable to it is immediately available to him. In addition, the company interviews each to learn what if any added skills and capabilities he acquired while in service, and these are taken into consideration in putting him on an available better job.

The company's program also embraces a specific policy for returning disabled veterans, providing training to equip him, if possible, for an available job which he can safely perform. In the


BECAUSE THE GAS IS Dry
BEFORE IT STARTS CROSS-COUNTRY
This Lectrodryer, charged with Alorco Activated Alumina, dries gas DRY

DRY GAS—gas dried by Alorco Activated Aluminas—will get to its destination on schedule. No freezing of valves. No frosting up of pipe lines along the way. No corrosion problems.

Automatic drying machines, charged with these efficient, sure drying agents, are located at the wells and spotted along the lines.

DRYing of air, gases and many organic liquids to very low dew points are jobs which Alorco Activated Aluminas have been performing well for years, in many industries. If you have a drying problem, you can get equipment which will solve it for you. Write ALUMINUM ORE COMPANY, Subsidiary of Aluminum Company of America, 1963 Gulf Building, Pittsburgh 19, Pennsylvania.

ALUMINUM ORE COMPANY

ALORCO

Aluminas and Fluorides

THE MONTH . . .

event a disabled veteran cannot do any work, the company's sick benefits apply and the firm aids him in getting government rehabilitation until he can return to work.

Synthetic Rubber Plants Needed at Least Two Years

Synthetic rubber production at almost maximum capacity of all existing plants is foreseen for a period of at least two years by officials of the Rubber Bureau, regardless of what condition the Far Eastern natural rubber plantations retaken from the Japs may be in.

A world long starved for rubber is seen as capable of absorbing whatever volume of the natural product may be available plus all the synthetic that can be produced over at least that long a period.

Washington has received no information regarding the condition of the British and Dutch plantations, and rumors of the rubber available there run from a few hundred tons to many hundred thousand tons.

Meanwhile, Congress will have to wrestle with the many problems involved in the rubber situation, among them whether the plants are to be continued in government hands or sold or leased to private industry. Their decision on that point may go far to determine whether the synthetic industry is to become a permanent part of our manufacturing structure.

Alcohol Angle

Consideration of the plants' future will bring up the old fight of the farm bloc to retain the three government alcohol plants in production. It is claimed that equipment now being installed to recover a full 100 percent of the by-products developed in the manufacture of alcohol will cut the cost of the latter to the point where it can compete with the synthetic product made from petroleum. A further argument will be that no irreplaceable natural resource should be used if a substitute can be provided.

Considerable emphasis also will be laid upon the desirability of the United States protecting itself against a recurrence of the situation which in 1942, when the Japanese over-ran the natural rubber areas, and it will also be argued that American rubber consumers should be safeguarded against hold-up prices, such as developed in the early 20's.

Rubber Bureau officials are convinced that there is a need for synthetic rubber permanently. They contend that butyl rubber (GRI when made in government plants) is superior to natural for inner tubes, and that neoprene (GRN) is best for fuel hose and other products where oil-resistance is required. The general purpose rubber (GRI) must be mixed with natural to provide a satisfactory truck tire, but it is claimed the synthetic passenger car tire is the equal now of the natural rubber tire produced before the war.

International Agreement?

Like petroleum, rubber is a commodity of international significance, and questions of national and international policy will be involved in any policy which Congress develops. It has long been proposed that an international convention be worked out of rubber, similar to the pending Anglo-American petroleum agreement which eventually is to be participated in by all oil producing and oil consuming nations.

It is the present intention of the Rubber Bureau, which is responsible for the policies followed by Rubber Reserve Company in operating the plants, to keep as many of the plants operating as possible. In the event the demand for synthetic rubber proves less than now anticipated, the highest cost units will be closed down first.

However, it is believed that almost capacity production will be required for the next two years, after which, it is believed, synthetic rubber will have to stand or fall on the two factors of price and quality.

Secretary Ickes Stays— At Least for Time Being

Secretary of the Interior Harold L. Ickes has set at rest doubts that he would long continue to attend President Truman's cabinet meetings by indicating that he would, after all, go to London to conduct the negotiations on the revised Anglo-American petroleum agreement.

Ickes made his statement a day after a talk with the President during which, apparently, an agreement was reached that he would retain his portfolio, for a time at least.

The President said Ickes would stay, could stay as long as he desired. His statement was flat and definite.

Ask Industry Executives To Attend London Parley

Cabinet-level conferences with the British looking toward an agreement on the revised Anglo-American petroleum pact will open in London September 17.

Secretary Ickes will lead the American delegation, other members of which will be Deputy Administrator Davies and Charles B. Rayner, petroleum adviser to the Department of State, and with them will go six leaders of the oil industry, all members of the national policy committee of the PIWC as technical advisers. The industry group will consist of William R. Boyd, Jr., president of the API and chairman of war council; A. Jacobsen, president of Amerada Petroleum Corporation and chairman of the oil policy committee; George A. Hill, Jr., president of Houston Oil Company; Walton Jones, president of Cities Service Oil Company; Joseph E. Pogue, vice president of Chase National Bank, and Ralph T. Zook, president of the Independent Petroleum Association of America.

The original agreement was signed August 8, 1944, by Lord Beaverbrook for the British government and then acting Secretary of State Stettinius for the United States. It was sent to the Senate for ratification by President Roosevelt on August 24, but was withdrawn when

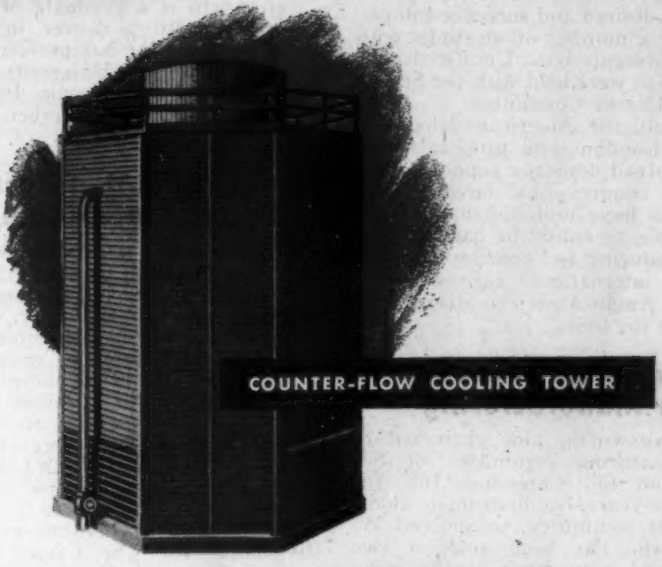
Crude Oil Runs to Stills, Production of Refined Products, and Stocks for the Four-Week Period Ending September 1, 1945

(Figures, in thousands of barrels of 42 U. S. gallons each, based on reports of American Petroleum Institute. Production and stocks include reported totals plus estimated amounts to make these figures on a Bureau of Mines Basis)

DISTRICT	Capacity Percent Reporting	Crude Runs to Stills: Daily Average	Crude Runs to Stills: Percent Operating	Production: Gasoline*	Production: Kerosine	Production: Gasoil and Dist. Fuel Oil	Production: Residual Fuel Oil	Stocks at Refineries, Terminals and in Pipe Lines: Finished and Unfinished Gasoline	Stocks at Refineries, Terminals and in Pipe Lines: Kerosine	Stocks at Refineries, Terminals and in Pipe Lines: Gasoil and Dist. Fuel Oil	Stocks at Refineries, Terminals and in Pipe Lines: Residual Fuel Oil	Crude Oil: Daily Average Production	Crude Oil: Stocks†
East Coast	99.5	787	99.5	8,039	856	4,304	6,922	14,724	5,547	12,061	7,907	.....	.....
Appalachian District 1	76.8	101	69.4	1,255	219	313	301	2,685	369	799	279	.....	.....
Appalachian District 2	81.2	61	122.5	787	29	200	415	1,230	61	177	212	.....	.....
Indiana, Illinois, Kentucky	87.2	792	92.4	11,332	1,135	2,683	4,021	17,972	2,609	5,552	2,919	.....	.....
Oklahoma, Kansas, Missouri	78.3	402	85.6	5,944	533	1,723	2,017	7,480	959	2,602	1,357	.....	.....
Inland Texas	59.8	248	75.2	4,040	342	570	1,814	2,547	286	427	993	.....	.....
Texas Gulf Coast	89.3	1,172	94.8	14,702	1,829	5,577	6,821	16,457	1,787	5,185	6,072	.....	.....
Louisiana Gulf Coast	96.8	269	103.6	3,538	963	1,487	1,477	3,873	901	1,801	1,079	.....	.....
North Louisiana, Arkansas	55.9	75	59.3	862	166	254	493	2,178	192	1,160	227	.....	.....
Rocky Mountain District 1	17.1	13	103.8	157	24	47	116	91	15	21	38	.....	.....
Rocky Mountain District 2	72.1	115	72.6	1,577	36	439	1,094	1,826	104	366	634	.....	.....
California	87.3	920	92.3	10,094	127	2,819	11,921	13,155	406	10,708	25,090	.....	.....
Total U.S. Sept. 1, 1945	85.8	4,957	91.2	62,327	6,259	20,416	37,252	84,218	13,234	40,859	46,807	4,909	211,813‡
Total U.S. Aug. 4, 1945	85.8	5,077	93.4	.....	.....	.....	.....	84,812	11,046	36,977	42,927	4,922	215,382
Total U.S. Sept. 2, 1944	.....	4,592	.....	.....	.....	.....	.....	78,362	13,389	40,754	59,872	4,657	223,482

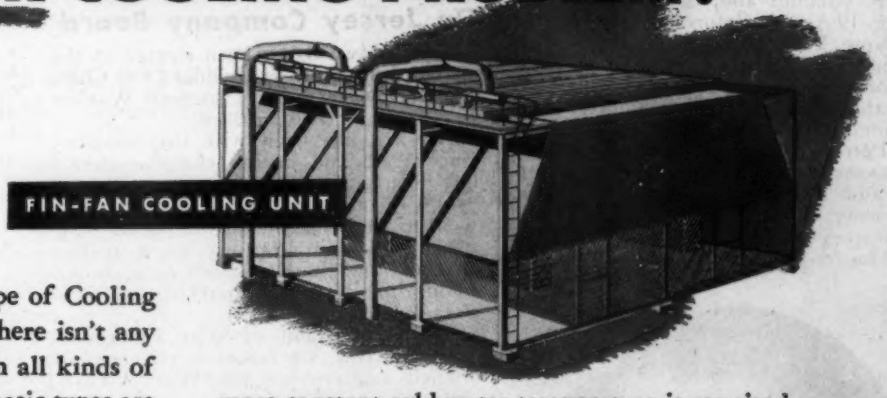
* Includes natural gasoline blended at refineries. † Bureau of Mines. ‡ August 25, 1945.

AERATOR COOLING TOWER



COUNTER-FLOW COOLING TOWER

WHAT IS YOUR COOLING PROBLEM?



FIN-FAN COOLING UNIT

FLUOR doesn't try to fit just one type of Cooling Unit to all cooling requirements. There isn't any cure-all. Years of field experience on all kinds of cooling problems proves that three basic types are necessary to meet widely different conditions... and Fluor builds all three.

1. The FLUOR atmospheric type *Aerator* Cooling Tower for installations where ground space is not a consideration..... and where prevailing wind conditions are suitable. 2. The FLUOR mechanical draft type *Counter-Flow* Cooling Tower for installation where ground space is limited and a more constant cold water temperature is required. 3. The FLUOR *Fin-Fan* Cooling Unit for installation where water is scarce or expensive and bottom temperatures desired are not approximately atmospheric temperature. FLUOR recommendations are based upon the correct unit for the specific conditions and requirements, backed by extensive field tests and broad engineering experience on all three types of Cooling Units.

BE SURE SINCE 1890 WITH FLUOR

FLUOR

Patents and Patents Pending

ENGINEERS • MANUFACTURERS • CONSTRUCTORS

PROCESS PLANTS AND EQUIPMENT FOR THE OIL, GAS AND ALLIED INDUSTRIES

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., LOS ANGELES 22 • New York, Pittsburgh, Kansas City, Houston, Tulsa, Boston

opposition arose in the industry which saw possibilities of federal control over domestic operations and contended excessive power was given the proposed international commission.

Government representatives did not agree, but expressed willingness to revise the document to give the industry the assurance it desired and succeeded in doing so after a number of meetings with industry representatives. Unofficial conversations also were held with the Senate Foreign Relations Committee.

As a result, the American delegation will go to London with proposals that have widespread domestic support in industry and congressional circles. Both governments have undertaken, as early as practicable, to enlist the participation of other producing and consuming countries in an international agreement for which the Anglo-American discussions will provide the basis.

Teitsworth Heads Socony-Vacuum Manufacturing

C. S. Teitsworth, vice chairman of the manufacturing committee of Socony-Vacuum Oil Company, Inc. for the past five years, has been made chairman of that committee, to succeed W. F. Burt, who has been made a vice president and a member of the executive committee.

Teitsworth has been associated with Socony-Vacuum and affiliated companies for 19 years. Before transferring to the New York office in 1934, he was for eight years with General Petroleum Corporation as supervisor of process laboratories at Los Angeles.

Prior to 1926, when he joined General Petroleum Corporation, Teitsworth was associated with the American Potash and Chemical Company, Trona, California; Fixed Nitrogen Research Laboratory of the War Department, Washington; Celite Company, Lompoc, California, and the Dicalite Company, Los Angeles. At the time of his transfer to New York in 1934, his specific assignment was to evaluate the commercial posibilities of catalytic cracking. He has been intimately associated with the development and commercialization of catalytic cracking since that time and is a director of Houdry Process Corporation. In 1936 he was appointed to the manufacturing committee as manager for the company's Mid-West refineries.

Teitsworth is a graduate of Stanford University with a degree in chemical engineering and he has performed graduate work at the University of Minnesota and the California Institute of Technology. He is a member of American Chemical Society.

DR. PHILIP G. MURDOCH

Shea Acting Manufacturing Manager Carter Company

Paul C. Shea, vice president of Colonial Beacon Oil Company, has been named acting manager of manufacturing for The Carter Oil Company, with headquarters at Billings, Montana. T. R. Corbett, chief refining enginer since May, 1944, has been named assistant manager, and will continue his headquarters at Billings.

Shea has been in charge of manufacturing for Colonial Beacon Oil Company at Everett, Massachusetts, and is on leave of absence to replace T. J. Landry, who resigned to become a marketing distributor for The Carter Oil Company at Kalispell, Montana.

Howard Succeeds Pratt On Jersey Company Board

B. B. Howard has been elected to the board of directors of Standard Oil Company (New Jersey), to succeed Wallace E. Pratt, recently retired.

Howard has been with the company since 1920, and during the war period has been general manager of its marine group throughout the world. In 1941 he went to England to expedite tanker turnarounds, and in 1942 was on a mission to India and Suez to speed cargo movements involving war materials for those areas.

He is president of War Emergency Tankers Inc., operator of government-owned tankers for the War Shipping Administration, a member of the board of managers of the American Bureau of Shipping and a director of the National Federation of American Shipping and of the American Merchant Marine Institute. He is a graduate of Annapolis, and was lieutenant commander in the Navy when he left the service after the first world war.

Murdoch Joins Chemistry Staff at Texas A. & M.

Dr. Philip G. Murdoch has accepted appointment as professor of chemical engineering at Texas Agricultural and Mechanical College, where he will conduct graduate courses and research. He will be consultant for some of the cooperative research that have been established at the college by industry.

Dr. Murdoch received his B.S. degree in 1929 and Ph.D. in 1932, both from California Institute of Technology. During the past 12 years he has been connected in various capacities with Shell Oil Company, most recently at New York.

Potter Heads Texas A. & M. Department of Physics

Dr. James G. Potter, war research physicist for Bell Telephone Research Laboratories, and former head of the department of physics at South Dakota School of Mines and Technology, became head of the physics department at Texas A & M College September 1.

Dr. Potter succeeds Dr. O. W. Silvey, department head since 1916, whose retirement to modified service was announced recently.

After undergraduate training for two years at Purdue University, Dr. Potter received his B. S. degree from Princeton, his M. S. degree from New York University, and did graduate work in physics at Massachusetts Institute of Technology and Yale University before receiving his Ph. D. from the latter in 1935. The next five years he was a member of the faculty at Illinois Institute of Technology, then in 1940 was made head of the physics department at South Dakota School of Mines and Technology. He went with Bell Telephone Research Laboratory in 1944 to serve more actively in the war program.

Since 1940, Dr. Potter has been chairman of the division of physics of the Society for the Promotion of Engineering Education, and the past two years has been program chairman for the American Association of Physics Teachers in its joint meetings with SPEE.

Dr. Potter is a son of Dr. A. A. Potter, long-time dean of the School of Engineering at Purdue University.

C. Z. Hardwick Heads Ohio Refining-Marketing Division

Charles Z. Hardwick has been elected a vice president of the company and manager of the refining and marketing department of The Ohio Oil Company, Findlay, Ohio. He succeeds C. L. Fleming, who retired after 47 years service with the company. Wilson B. Emery, vice president and manager of production, succeeds Fleming on the board of directors.

Hardwick joined the company in 1921,

C. Z. HARDWICK

MANY CORROSION RESISTANT ALLOYS AVAILABLE

FOR MODERN REFINERY PRACTICE

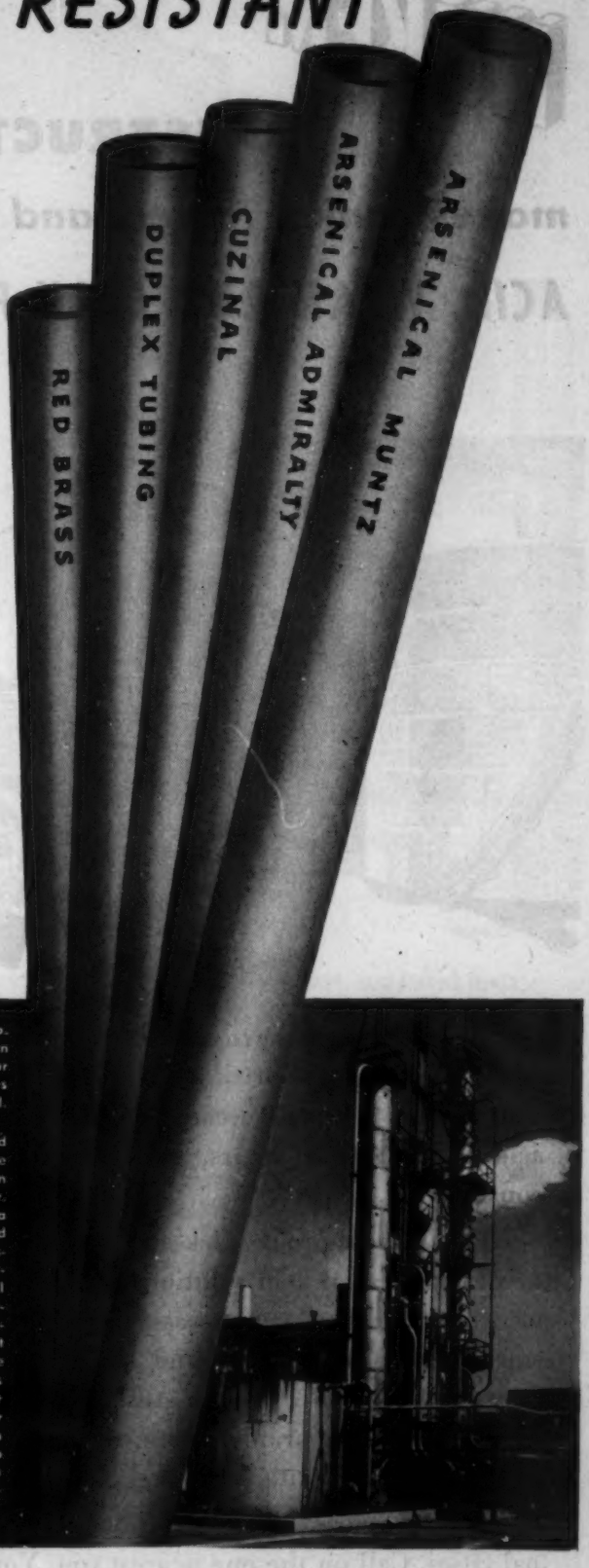
Through research, the petroleum refining industry is producing miracles. These miracles are often responsible for changes in methods and equipment which have brought with them more difficult corrosion problems.

Bridgeport also has a consistent program of research and development. Through special laboratory corrosion studies together with field and service tests, the behavior of various alloys in different corrosive media is determined. Bridgeport offers a variety of condenser and heat exchanger tube alloys, each of which has special qualifications as far as corrosion resistance is concerned.

Bridgeport's Technical Service Department is set up to help engineers and operators solve difficult corrosion problems associated with the petroleum, chemical and processing industries. In the interests of reducing interrupted service and costly maintenance and increasing tube life, it may be advantageous for you to try out several different types of alloys under actual operating conditions.

Contact your nearest Bridgeport office for help. Also write for 112-page Condenser Tube Manual containing specifications, corrosion research data, methods of installing and suggestions for increasing tube life.

"Bridgeport" BRASS CO. BRIDGEPORT BRASS COMPANY
BRIDGEPORT 2, CONN. • *Established 1865*



ARSENICAL ADMIRALTY—The most popular alloy for all 'round condenser and heat exchanger applications involving salt or polluted fresh circulating water, most petroleum products such as hydrocarbon gases containing some sulphur compounds, lubricating oils, gasoline, naphtha, etc.

ARSENICAL MUNTZ—For resisting sulphur attack on the oil side and dezincification on the water side. Considerably more corrosion resisting than ordinary Muntz.

CUZINAL—Superior to Admiralty in its resistance to air impingement corrosion or erosion-corrosion associated with high water velocities. Contains arsenic as an inhibitor of dezincification. Fair resistance to sulphide corrosion such as that encountered in gasoline and naphtha condensers and coolers.

CUPRO NICKEL—Withstands high temperature better than most non-ferrous alloys. Resists season or stress corrosion cracking generally caused by the combined action of moist ammonia, oxygen and stress. Useful in handling caustic and other alkaline liquors. Contains 0.5% iron for maximum resistance to impingement and other corrosion.

RED BRASS—For resisting the action of corrosive waters and for cooling hydrocarbon vapors. Not recommended for severe sulphur corrosion conditions. More resistant to stress corrosion cracking than Admiralty or Cuzinal.

BRIDGEPORT'S DUPLEX TUBING was developed for corrosive conditions too severe for a single metal or alloy such as ammonia vapor on one side and circulating water on the other. Duplex Tubing is widely used for ammonia refrigeration, formaldehyde condensers and for many applications in chemical and processing industries. Many combinations are available such as Admiralty, red brass, Cuzinal (aluminum brass), cupro nickel, Muntz, Duronze IV (aluminum bronze) with steel, aluminum, stainless or monel. Two different materials are combined to withstand double corrosion and improve heat transfer properties under service conditions. The heat transfer characteristics are improved because a proper selection of materials results in a tube which does not form thick corrosion films or scales to hinder heat transfer. Write for Technical Bulletin on Duplex Tubing, containing suggested applications and methods of installing.

Condenser and Heat Exchanger Tubing

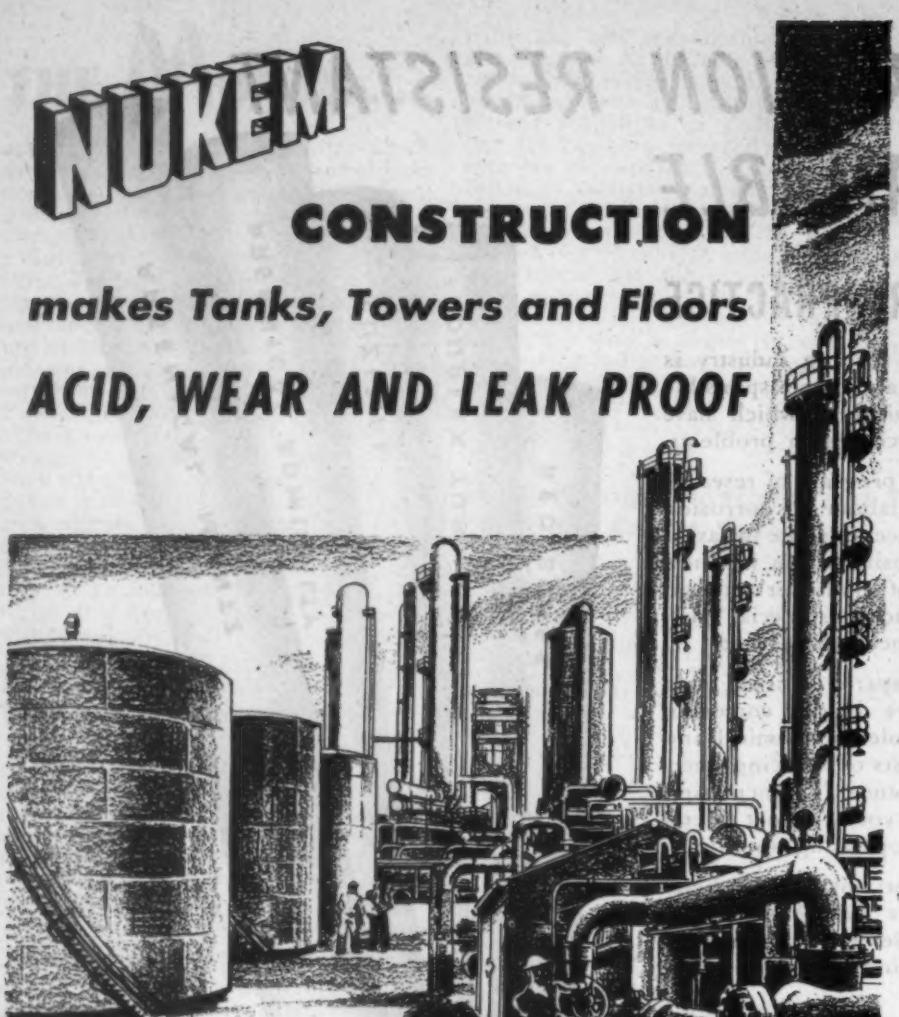
BRIDGEPORT BRASS

NUKEM

CONSTRUCTION

makes Tanks, Towers and Floors

ACID, WEAR AND LEAK PROOF



WHEREVER you have an acid condition in your refinery, NUKEM acid-proof brick and cement construction will prevent leakage and resist wear. Leading refineries protect their acid tanks, towers, floors, gutters and pits with NUKEM construction.

NUKEM acid-proof brick and cement are highly resistant to all commercial acid solutions irrespective of temperature or strength. They are successfully used in processing and storage tanks of all sizes and shapes. NUKEM tanks and floors installed in 1930 are still in excellent condition. Regardless of your problem, one of the NUKEM acid-proof cements will solve it.

NUKEM representatives are located in most of the principal cities. Call on the one nearest you. You'll find his knowledge and experience valuable.

NUKEM PRODUCTS CORPORATION

115 Colgate Avenue NUKEM **Buffalo 20, N. Y.**

THE MONTH...

C. L. FLEMING

as a clerk in a production field office in Louisiana. In 1928 he transferred to Robinson, Illinois, in charge of refining and marketing. Since 1934 he has been assistant manager of the refining and marketing department. He is a member of the board of councillors of the American Petroleum Institute.

Fleming started as office boy in the company's Oil City office on June 10, 1898. Transferred to Findlay two years later as a stenographer in the executive offices, he was made assistant secretary in 1915, secretary in 1918, and a director in 1927. He was elected a vice president in 1928, and handled crude oil sales until put in charge of the refining and marketing department in 1934. He was presented a diamond mounted gold service pin upon retirement.

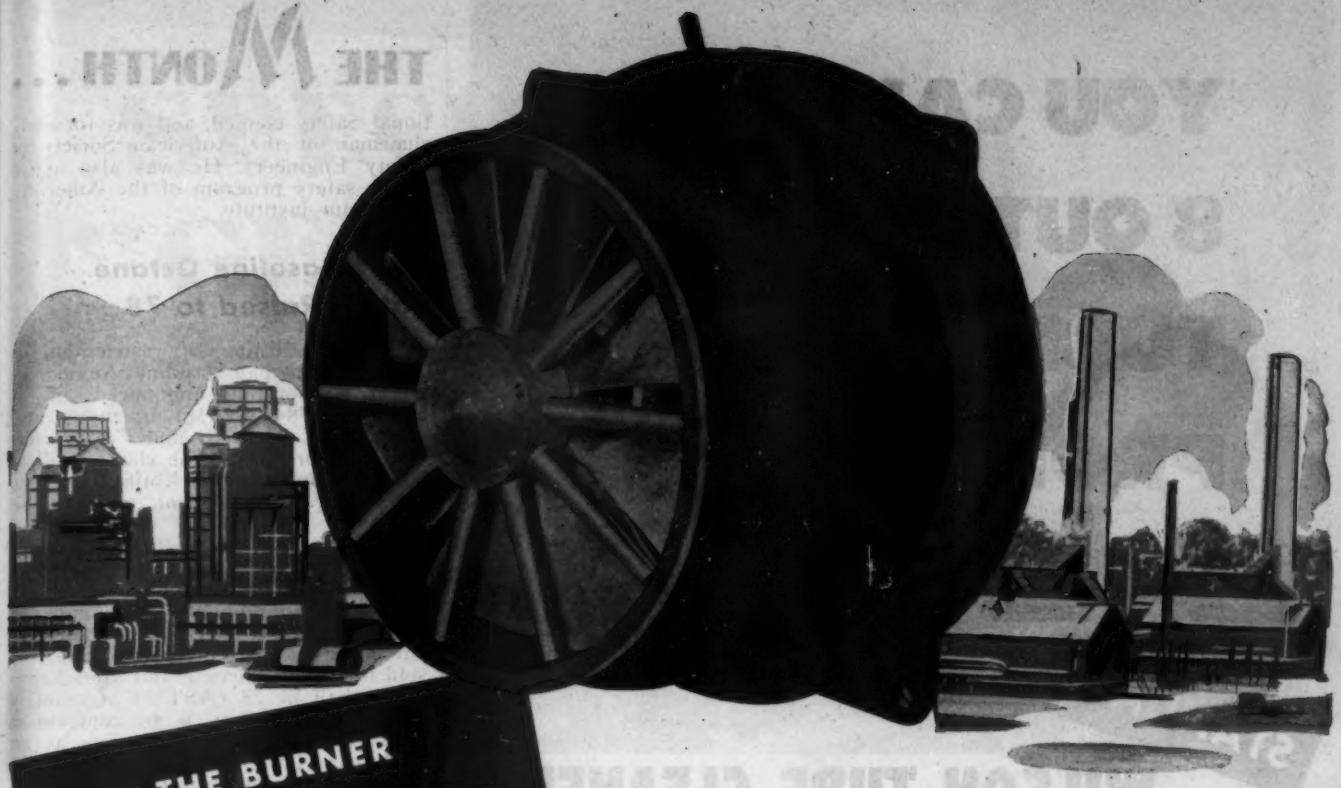
Fleming has been prominent in the civic affairs of Findlay. He is a member of the American Petroleum Institute, and in 1942 was elected a member of the board of trustees of National Petroleum Association.

Smith Retires as Head Of Indiana Safety

Clyde W. Smith, manager of the safety department of Standard Oil Company (Indiana) who established the first safety department in the petroleum industry when he joined the company's Whiting refinery in 1918, has retired because of ill health.

Five years after safety work was established in the manufacturing department it was extended to the sales department. Under Smith's direction the company's refineries have set several world safety records and other units of the manufacturing and sales departments have won many safety awards.

Smith was vice president for two years and a member of the executive committee for seven years of the Na-



THE BURNER that makes a new Boiler EASIER TO BUY

***Thorough, accurate mixing of fuel and air . . . complete combustion . . . with Coppus-Dennis* FANMIX**

When planning new gas or oil fired boilers, you can count on investing less in boiler, stack and auxiliary equipment — if you select a Coppus-Dennis FANMIX Burner. Coppus equipment was used for instance in 93% of 191 petroleum refinery plants built for war use.

FANMIX Saves Combustion Space

FANMIX delivers to the furnace a homogeneous mixture of fuel and air, without blow-torch action. Combustion is rapid and complete — so smaller combustion space is needed than when the furnace must serve as mixing chamber as well — or ratings of present equipment can be increased.

FANMIX Creates Own Forced Draft

Less furnace draft is needed than with any other burner, because FANMIX creates its own forced draft, thus overcoming draft loss across the burner (at any operating range). Less stack is needed, and forced draft equipment can be eliminated entirely.

There are two FANMIX types—one to handle natural gas, the other a combination type to burn either gas or oil in entirety or gas and oil in any proportion. (No oil guns needed).

Coppus engineers FANMIX Burners for individual applications. Complete control over rate of combustion or "flame pattern" can be provided to meet the requirements of any installation. Coppus Engineering Corporation, 289 Park Ave., Worcester 2, Mass. Sales offices in THOMAS' REGISTER. Other Coppus "Blue Ribbon" products in SWEET'S, CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG.

New Bulletin Will Help You When Installing New Equipment or Modernizing Old

ANOTHER

COPPUS

"BLUE RIBBON" PRODUCT

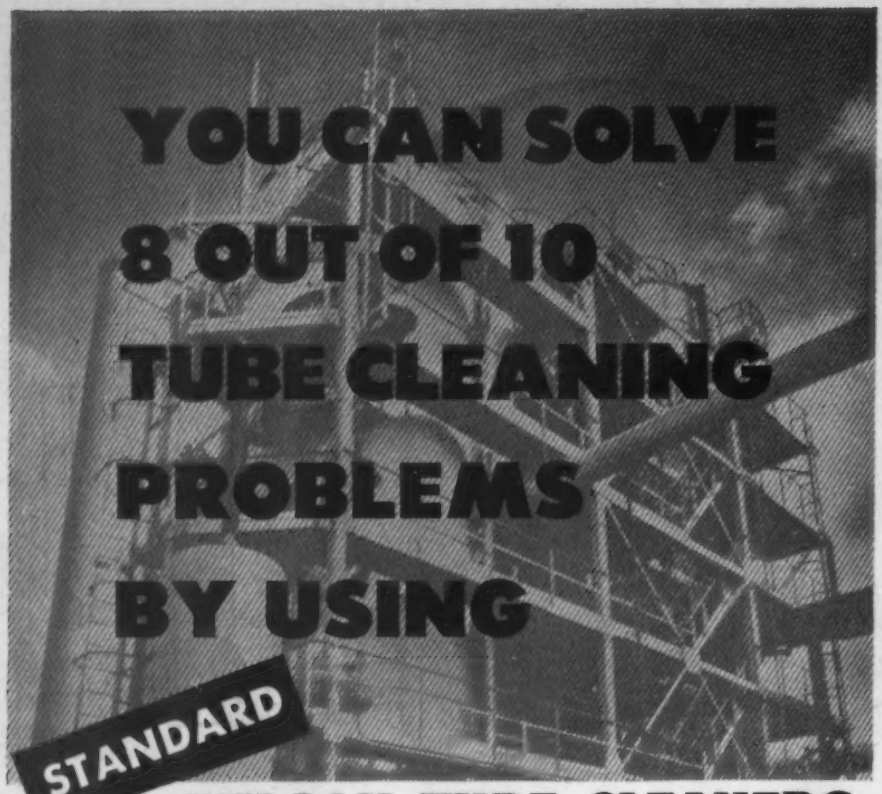
COPPUS ENGINEERING CORP.
289 Park Ave.,
Worcester 2, Mass.

Please send Bulletin 410-4 to

Name.....

Company.....

Address.....



WILSON TUBE CLEANERS

Yes, you can solve almost all tube cleaning problems without resorting to expensive or unusual equipment—if you use standard Wilson Tube Cleaners!

A recent survey shows that 80% to 90% of thousands of tube cleaning problems presented to Wilson Engineers can be solved easily when the right combination of Standard Wilson equipment is used.

You can choose a motor, cutter head, flexible shaft or other accessory from the complete line of Wilson Tube Cleaners, and assemble a cleaner that will help you get your tubes *cleaner, faster* and save you money as well as time.

A copy of the Wilson Tube Cleaners Check List will show you how to choose the right equipment. It contains a handy Tube Cleaner Selection Guide to help you pick the right motor, cutter head and accessory for any fouled tube condition. In addition there is a list of hints on maintenance and operation that will go a long way towards making your job pleasanter and your tube cleaners last longer.

Be prepared for tube cleaning emergencies. Send for your free copy of bulletin 75 today.

MODERN TUBE CLEANERS FOR THE PROBLEMS OF TODAY.

wilson
PIPE AND TUBE CLEANERS EXCLUSIVELY

TW-692

THOMAS C. WILSON Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

THE MONTH...

tional Safety council, and was formerly chairman of the American Society of Safety Engineers. He was also active in the safety program of the American Petroleum institute.

Ethyl Gasoline Octane Rating Raised to 78

With the lifting of restrictions on quality of civilian gasoline August 15, Ethyl Corporation announced an increase to 78 (ASTM) in motor fuel sold by its licensees under the trademark authorization. The change will be effective November 15. Notification from E. W. Webb, president, was to this effect:

"We are amending, effective November 15 . . . the license and sales agreement between our respective companies so that the minimum octane number of treated gasoline sold under trademark authorization or red-colored gasoline sold under the license and sales agreement shall be 78 (ASTM) at point of sale. Also volatility is to conform in both cases to type B gasoline as set forth in ASTM D-439-40-T. Under existing circumstances we feel that your company may wish to put this amendment into effect as soon as may be practicable . . ."

Many Witnesses Scheduled For FPC Gas Investigation

A long list of witnesses will confront the Federal Power Commission at the opening of its natural gas investigation at Kansas City September 18.

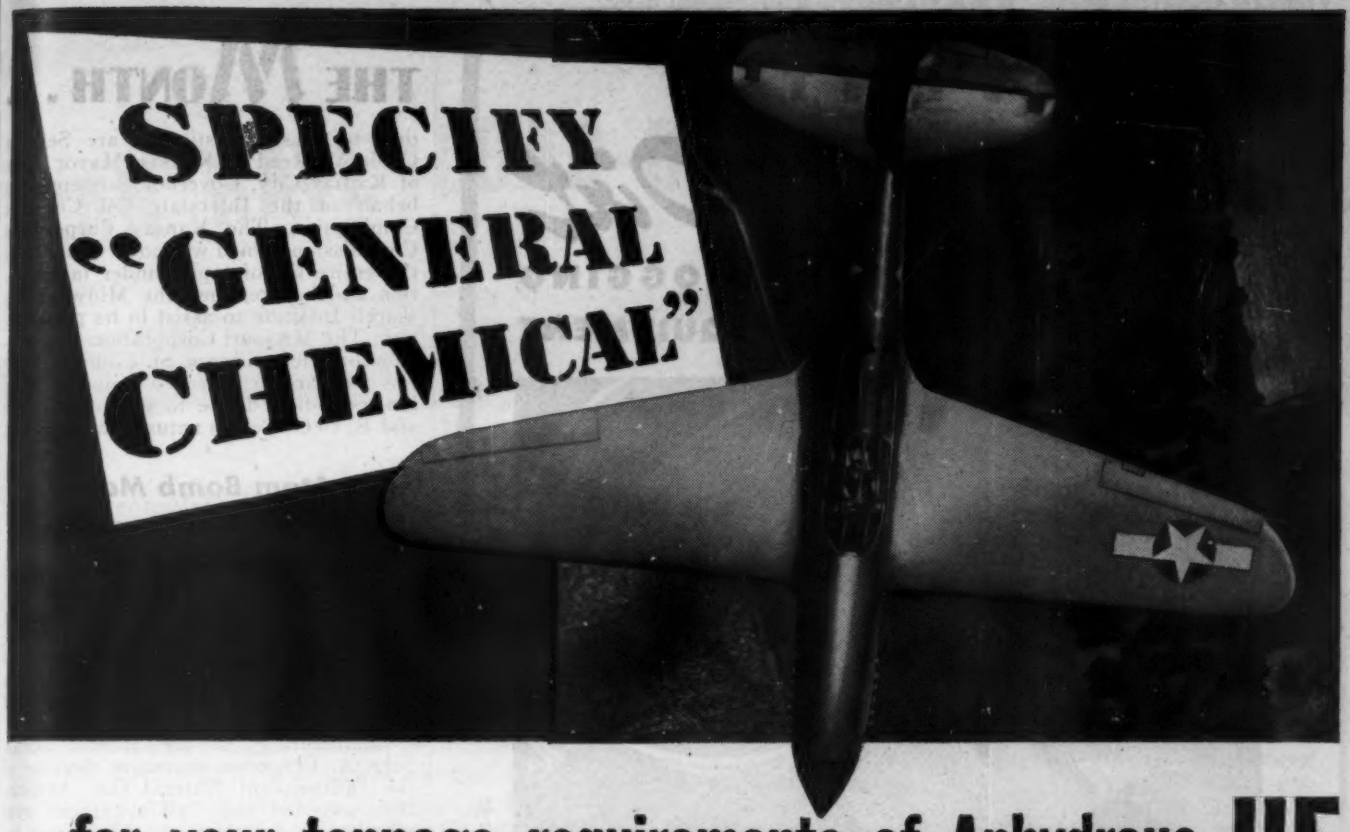
The commission has scheduled three weeks for the initial hearing and officials last week expressed the opinion that the full period will be required.

While the Kansas City sessions will cover the whole gamut of topics long since outlined by the committee, they are expected to develop only one of two of the major issues which are to be considered. Requests for time by representatives of the coal industry indicate that the first big issue will be that of gas vs. coal in the industrial communities in the coal-producing areas.

Commission officials said that this issue is one of grave social and economic importance and that an extensive study will be made of the coal and railroad industries' contention that it is not wise national policy to permit the use of a high-value fuel in areas where a low-value fuel is available. The controversy over the use of gas in the coal areas, it was pointed out, raises such side issues as the future of the coal industry and the employment of miners, the rapid depletion of natural gas reserves and relative factors.

A second big issue is expected to come up when the hearings move south and the big gas-producing states present their demand for federal action to prohibit or limit the export of gas, over which the states have no power by reason of the fact that the movement is interstate and solely within the jurisdiction of the federal government.

Among witnesses who have asked for



...for your tonnage requirements of Anhydrous HF

As one of America's foremost producers of Anhydrous Hydrofluoric Acid, General Chemical Company is in a particularly advantageous position to furnish this vital catalytic chemical for Industry's growing requirements.

The Company's ever-expanding HF production program now includes units strategically located from coast to coast. With such plant capacity, plus raw materials from its own fluorspar mines and sulfuric acid facilities, General thus provides a readily accessible source of supply at all times.

Remember—advanced manufacturing "know how"—the outgrowth of technological experience gained in over 30 years' production of Hydrofluoric Acid—is your assurance of a superior product.

For your tonnage requirements of Anhydrous HF and for other basic chemicals for Petroleum—

SPECIFY THESE GENERAL CHEMICAL PRODUCTS

Sulfuric Acid—Oleum—Anhydrous Hydrofluoric Acid: Alkylation

Fluosulfonic Acid: Polymerization

Muriatic Acid: Oil Well Acidizing

Sodium Metasilicate—Disodium Phosphate—Trisodium Phosphate—Tetrasodium Pyrophosphate: Detergents

Aluminum Chloride Solution—Aluminum Sulfate: Treating Agents

Sodium Silicate—Disodium Phosphate—Trisodium Phosphate Tetrasodium Pyrophosphate: Mud Conditioning

Other Chemicals: Aqua Ammonia—Nitric Acid—Potassium Nitrite

BAKER & ADAMSON REAGENTS AND FINE CHEMICALS

BASIC CHEMICALS

GENERAL CHEMICAL COMPANY

FOR AMERICAN INDUSTRY

New Technical Bulletin—General Chemical Technical Service Bulletin No. 30-A "Hydrofluoric Acid, Anhydrous and Aqueous"—presents many important original data. Twenty-four pages of curves, charts, bibliography, etc., with particular emphasis on the physical properties of Anhydrous HF and its use in organic syntheses. Write nearest General Chemical Sales and Technical Service Office.

GENERAL CHEMICAL COMPANY

40 Rector Street • New York 6, N. Y.

Sales and Technical Service Offices: **Atlanta • Baltimore • Boston • Bridgeport (Conn.) Buffalo • Charlotte (N. C.) • Chicago • Cleveland • Denver • Detroit • Houston • Kansas City • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh • Providence (R. I.) San Francisco • Seattle • St. Louis • Utica (N. Y.) • Wenatchee & Yakima (Wash.)**

In Wisconsin: General Chemical Wisconsin Corp., Milwaukee, Wis.

In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

PREVENT

Rust·Scale·Dirt

FROM CLOGGING
STEAM EQUIPMENT

YARWAY

STRAINERS

"The Screen's the Thing"

- *A High Grade Monel Woven Wire Basket* with mesh fine enough to catch the dirt—yet ample free area for passage of clean condensate, oil and other fluids.
- *Body Cadmium Plated Inside and Out for Protection Against Corrosion.*
- *Readily Removed Steel Blow-Off Bushing.*
- *Bushing Automatically Aligns Screen.*
- *Thousands in Use—Sold by Over 100 Mill Supply Houses.*
- *6 Sizes ½" to 2" for Pressures up to 600 Lbs.*

See Your Supply House or write for Bulletin S-200

YARNALL-WARING COMPANY

128 MERMAID AVENUE PHILADELPHIA 18, PA.

YARWAY STRAINERS

THE MONTH...

time to present testimony are Senator Clyde M. Reed of Kansas, Mayor Gage of Kansas City, Governor Schoeppel on behalf of the Interstate Oil Compact Commission, The Kansas Corporation Commission, which will cover practically the entire list of topics under investigation and has retained the Midwest Research Institute to assist in its presentation, The Missouri Corporation Commission for brief evidence, St. Louis authorities who are expected to bring up their long standing desire to get natural gas and E. DeGolyer on natural gas reserves.

Says Atom Bomb Makes Gas Saving Unnecessary

Possibilities of atomic energy raised by the perfection of the bomb which blew Japan out of the war will be the basis of a new drive on the part of the natural gas industry for the lifting of all restrictions on the exportation of gas from producing states, it was disclosed last week.

Commenting on the atomic bomb, John A. Ferguson, executive director of the Independent Natural Gas Association, asserted that "all argument over whether or not there should be any restrictions imposed on the exportation of natural gas and whether or not its end use should be curbed should now be closed."

While Ferguson did not attempt to minimize the time which may be required for the perfection of methods for utilizing the power of the atom, he took the stand that there is no longer any basis for contentions that natural gas should be held by the producing states to attract industry and for the use of future generations.

"Conservative estimates made recently by the most competent authorities reveal that there are sufficient natural gas reserves now to last for some 50 years," he said. "If science continues to make the progress on the use of the atom in generating power that it has made in recent years it is not impossible that natural gas, along with gasoline, coal, electricity and all forms of power generation could become obsolete before the present known reserves of any of the depletable resources are utilized.

"A development such as this (atomic power) is a complete answer to those who urge the hoarding of natural gas for future generations. The natural gas industry has long contended that technological developments would always provide sources of power and energy. It is unreasonable to argue that the owner of a commodity, such as natural gas, should be denied the right to market it and in 25 or 50 years be faced with obsolescence."

The coal and railroad industries, Ferguson asserted, have fought the competition of natural gas on the ground that reserves were rapidly becoming exhausted and therefore gas should not be exported from the producing areas or used for what they termed "inferior" purposes. The atomic bomb, he held, has "thoroughly exploded" their arguments.

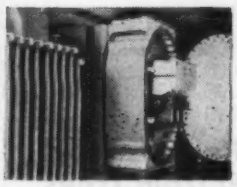
"Coming as it does shortly before the beginning of the FPC natural gas hearings," he said, "it seems that most, if not

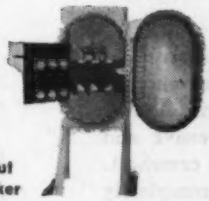
CAN HAVE LOAD-CENTER POWER

Our complete line of metal-enclosed unit substations enables you to benefit from LOAD-CENTER DISTRIBUTION throughout the refinery

Have you been unable to take full advantage of the LOAD-CENTER SYSTEM of power distribution because of semi-hazardous conditions in certain parts of your refinery? It is in these locations that the benefits of load-center distribution are most needed. You will be glad to know that the complete line of G-E unit substations now includes units specially designed for use in semi-hazardous locations in refineries.

Each substation consists of a primary power circuit breaker or interrupter switch, a standard transformer section, a secondary bus enclosure, and any desired number of circuit breakers.





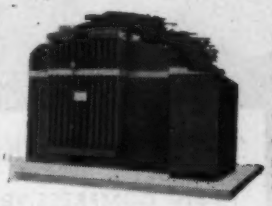
Swing open the cover

Swing out the breaker

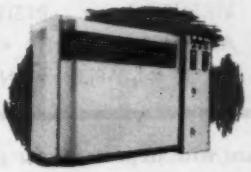
Air circuit breakers are easily removed for inspection or maintenance. Breaker enclosures are explosion-proof, with all arcing parts in enclosures for Class I, Group D, locations, as defined in the National Electrical Code. Adequate interrupting capacity is provided in these units. The insulating and cooling liquid in the transformer cannot burn or give off explosive vapors.

Completely factory-built, these units may be put anywhere, indoors or outdoors. In combination with standard G-E unit substations, they make it possible for you to set up a well-organized power system throughout the refinery, reducing voltage drop, and eliminating the danger of inadequate interrupting capacity. Before you formulate any plans for increased power supply, have a G-E application engineer show you additional data on the advantages of G-E unit substations for refinery use. *General Electric Co., Schenectady 5, N. Y.*

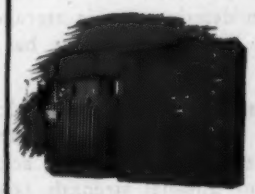
The G-E Unit Substation Family for Long-range Power Planning



MASTER UNIT SUBSTATION. A complete packaged substation for multifeeder radial or network systems, with or without bus-voltage regulation. A metal-clad weatherproof enclosure around switchgear offers a high degree of safety to personnel. Units are available in sizes from 750 kva to 25,000 kva.



LOAD-CENTER UNIT SUBSTATION. G.E. offers units, in sizes from 100 to 2000 kva, equipped with either Pyranol* or dry-type transformers, depending upon your requirements. This unit substation for indoor service has a dry-type transformer.



D-C UNIT SUBSTATION. This d-c unit substation consists of completely metal-enclosed a-c switchgear, a transformer, and a metal-enclosed, sealed-ignitron mercury-arc rectifier with enclosed control, and d-c switchgear. Available in ratings of 75 to 500 kw at 250 volts and 100 to 1000 kw at 600 volts.

CONTROL-CENTER UNIT SUBSTATION. For centralized low-voltage control, a unit substation with Cabinetrol is recommended. Full-voltage, reduced-voltage, single-speed, multispeed, and reversing starters can be grouped and interlocked in any required sequence.

*Trade-mark reg. U.S. Pat. Off.

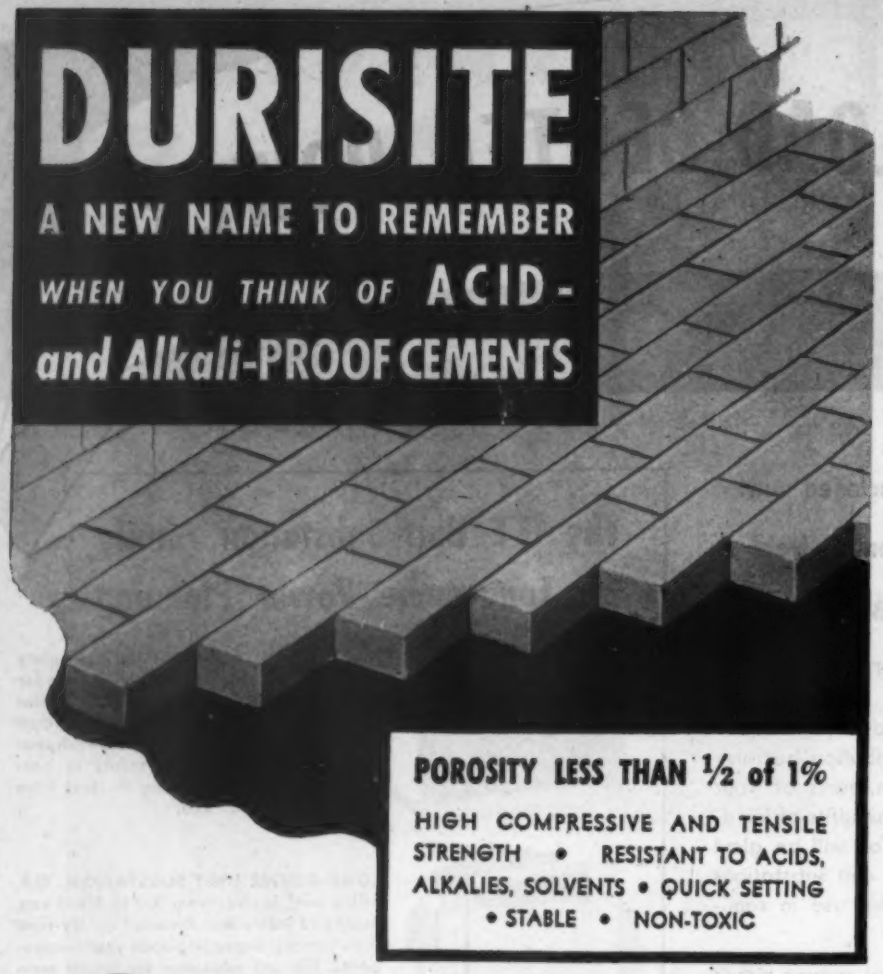
GENERAL ELECTRIC

654-40-189

Buy all the BONDS you can—and keep all you buy

DURISITE

A NEW NAME TO REMEMBER WHEN YOU THINK OF ACID- and Alkali-PROOF CEMENTS



POROSITY LESS THAN ½ of 1%

HIGH COMPRESSIVE AND TENSILE STRENGTH • RESISTANT TO ACIDS, ALKALIES, SOLVENTS • QUICK SETTING • STABLE • NON-TOXIC

DURISITE is a resinous cement with important *new* properties. Unlike most resinous cements, it is completely stable in storage. You can carry supplies on hand ready for use when needed. No vexatious delays while orders clear. No costly waste from deterioration in storage. And, unlike most resinous cements, Durisite is non-toxic. Durisite has no dangerous effect on the skin.

Durisite will handle most acids (including hydrofluoric in all concentrations), alkalies of any degree of strength, all oils and solvents, at temperatures up to 350°-375° F. It will handle strong acids and alkalies alternately. Durisite is a cement of unusual strength (compressive and tensile strength is approximately four times that of silicate-type cements). Durisite's dense, non-porous structure is permanent, remaining completely non-absorbent and impermeable even at elevated temperatures.

Durisite is a quick-setting cement. Brick can be laid as fast as the workmen can handle them, course upon course, with no danger of the mortar being squeezed out from the lower courses.

Time proven in extensive laboratory and field tests over a period of three years, Durisite is setting new records for durability in tough acid-*and-alkali*-proof masonry construction.

THE U. S. STONEWARE CO.

Dept. PR, P. O. Box 350 Akron, Ohio

Please mail me_____copies of your new Research Bulletin R-5 on Durisite Cement.

*Name*_____ *Company*_____

*Position*_____ *Address*_____

U. S. STONEWARE

Since 1865 *Akron, Ohio*

THE MONTH...

all, of the opposition to the position taken by the natural gas industry concerning exportation and use has been left high and dry.

"In the light of developments, any effort to convince the FPC that natural gas markets should be restricted in any way would appear foolish."

Natural Gasoline Shows Its First Downward Trend

June production of natural gasoline and allied products showed a downward trend for the first time in a number of months, with a daily average of 12,993,000 gallons compared with 13,151,000 gallons in May, the Bureau of Mines' monthly report shows.

Total production for the first half of the year was 2,357,251,000 gallons, compared with 2,004,567,000 gallons for the same period in 1944, a daily average of 13,023,000 gallons against 11,014,000 gallons.

Production during June included 183,309,000 gallons of natural gasoline against 187,951,000 gallons in May; 32,320,000 gallons of natural gasoline mixture against 32,935,000 gallons; 34,113,000 gallons of raw condensate against 36,563,000 gallons; 19,571,000 gallons of commercial butane-propane mixture against 21,856,000 gallons; 32,301,000 gallons of normal butane against 35,991,000 gallons; 21,735,000 gallons of propane against 25,029,000 gallons; 16,090,000 gallons of other liquefied petroleum gases against 17,474,000 gallons; 13,885,000 gallons of iso-butane against 14,374,000 gallons; 12,050,000 gallons iso-pentane against 13,075,000 gallons; 21,181,000 gallons finished gasoline and naphtha against 19,423,000 gallons, and 3,231,000 gallons of other products against 3,124,000 gallons.

Stocks declined more than three percent during the month, it was shown, those at plants and terminals dropping from 107,001,000 to 100,228,000 gallons while at refineries they increased from 97,650,000 to 98,154,000 gallons.

Russians Report Good Motor Fuel from Trees

An aviation gasoline component "twice as efficient as iso-octane" is being produced from turpentine in the U.S.S.R., it is reported in the Russian scientific literature, which is translated and reviewed by J. G. Tolpin, editor of Universal Oil Products Company's survey of foreign petroleum literature.

It is stated that this anti-knock compound, which is named "Uratol," resulted from the research of V. G. Plyusnin in the Ural division of the Academy of Sciences, and was produced in large-scale laboratory equipment as early as 1943.

The statement is made that turpentine also is employed to some extent as a regular motor fuel for trucks, tractors and other motorized equipment used in the lumber industry, although its principal present function seems to be to start engines which operate on producer gas.

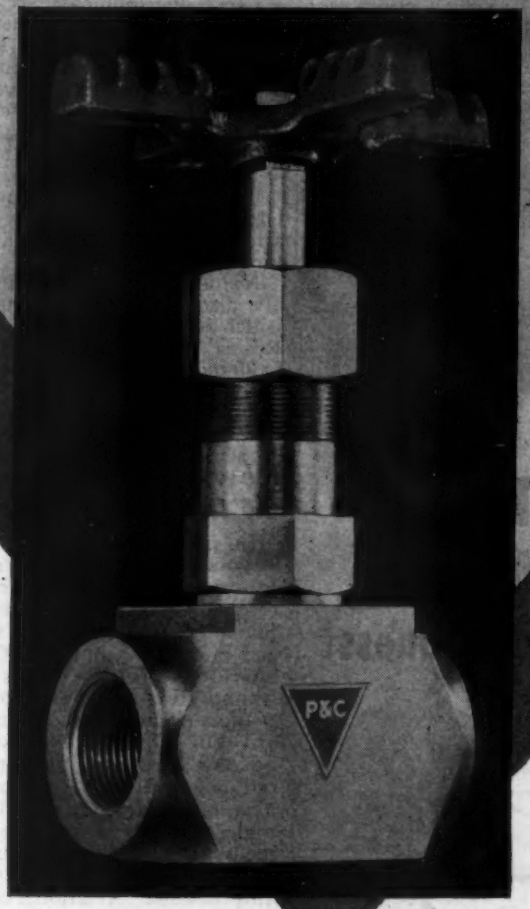
According to one author, the use of turpentine as a motor fuel presents considerable difficulty, particularly with respect to acidity and gum, and larger carburetor jets are necessary because of

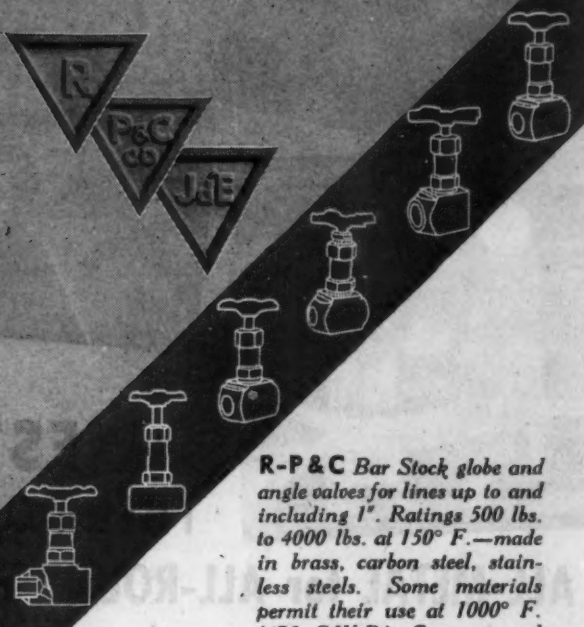
There's a Story behind this fine Valve

It is designed for severe throttling service. It is precision-made of rigidly controlled materials—for high working pressures. It is a Bar Stock valve—originated, developed and improved by **R-P&C** engineers. But that is only a part of the story.

This fine valve is one of a line that is still made under the "high working pressure" of wartime demands—in spite of the "severe throttling" of wartime shortages. And yet these Bar Stock valves are the best ever produced by **Reading-Pratt & Cady.**

It is a fact that **R-P&C** are making better valves today than ever before. We believe that's worth remembering next time you need valves.





***R-P&C** Bar Stock globe and angle valves for lines up to and including 1". Ratings 500 lbs. to 4000 lbs. at 150° F.—made in brass, carbon steel, stainless steels. Some materials permit their use at 1000° F. (475 S.W.P.) Compact and sturdy for their ratings—low in price for their superior performance and long life.*

R-P&C offers you a single responsible source for bronze, iron and steel gate, globe, angle and check valves—cocks and Lubrotite gate valves—bar stock valves—cast steel fittings—D'Este Automatic Valves and Engineering Specialties.

READING-PRATT & CADY

MANUFACTURERS OF
READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

Reading, Pa. • Atlanta • Boston • Chicago • Denver • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Bridgeport, Conn.

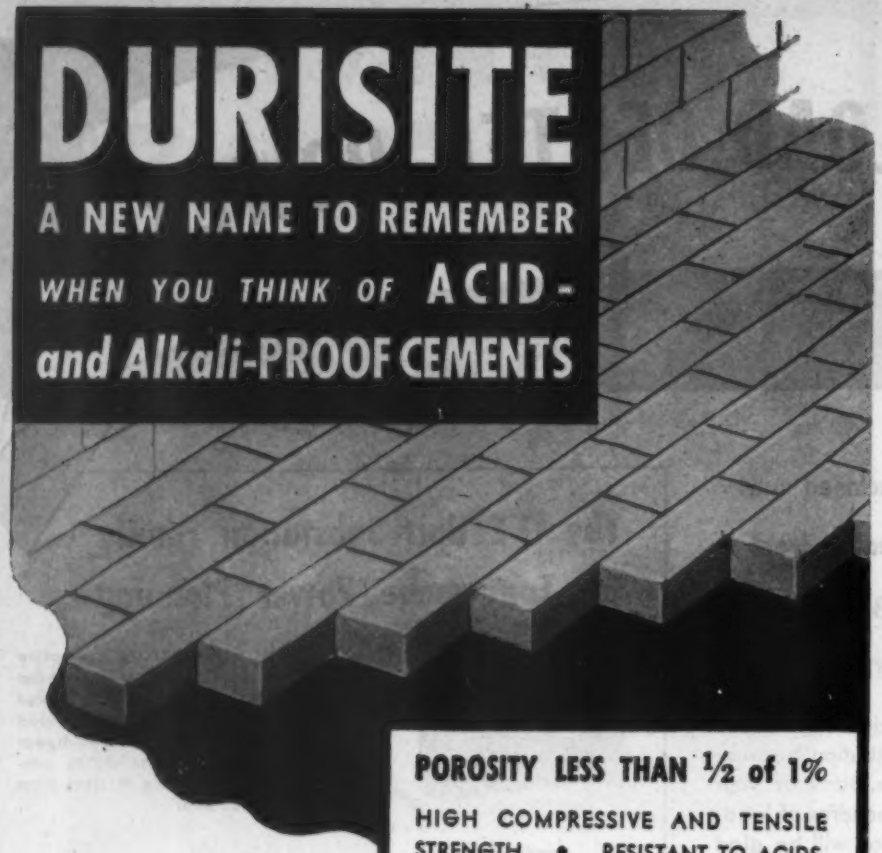
ACCO

TRADE MARK

READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE

DURISITE

A NEW NAME TO REMEMBER WHEN YOU THINK OF ACID- and Alkali-PROOF CEMENTS



POROSITY LESS THAN ½ of 1%

HIGH COMPRESSIVE AND TENSILE STRENGTH • RESISTANT TO ACIDS, ALKALIES, SOLVENTS • QUICK SETTING • STABLE • NON-TOXIC

DURISITE is a resinous cement with important *new* properties. Unlike most resinous cements, it is completely stable in storage. You can carry supplies on hand ready for use when needed. No vexatious delays while orders clear. No costly waste from deterioration in storage. And, unlike most resinous cements, Durisite is non-toxic. Durisite has no dangerous effect on the skin.

Durisite will handle most acids (including hydrofluoric in all concentrations), alkalies of any degree of strength, all oils and solvents, at temperatures up to 350°-375° F. It will handle strong acids and alkalies alternately. Durisite is a cement of unusual strength (compressive and tensile strength is approximately four times that of silicate-type cements). Durisite's dense, non-porous structure is permanent, remaining completely non-absorbent and impermeable even at elevated temperatures.

Durisite is a quick-setting cement. Brick can be laid as fast as the workmen can handle them, course upon course, with no danger of the mortar being squeezed out from the lower courses.

Time proven in extensive laboratory and field tests over a period of three years, Durisite is setting new records for durability in tough acid-*and-alkali*-proof masonry construction.

THE U. S. STONEWARE CO.

Dept. PR, P. O. Box 350 Akron, Ohio

Please mail me_____copies of your new Research Bulletin R-5 on Durisite Cement.

*Name*_____ *Company*_____

*Position*_____ *Address*_____

U. S. STONEWARE

Since 1865 *Akron, Ohio*

THE MONTH...

all, of the opposition to the position taken by the natural gas industry concerning exportation and use has been left high and dry.

"In the light of developments, any effort to convince the FPC that natural gas markets should be restricted in any way would appear foolish."

Natural Gasoline Shows Its First Downward Trend

June production of natural gasoline and allied products showed a downward trend for the first time in a number of months, with a daily average of 12,993,000 gallons compared with 13,151,000 gallons in May, the Bureau of Mines' monthly report shows.

Total production for the first half of the year was 2,357,251,000 gallons, compared with 2,004,567,000 gallons for the same period in 1944, a daily average of 13,023,000 gallons against 11,014,000 gallons.

Production during June included 183,309,000 gallons of natural gasoline against 187,951,000 gallons in May; 32,320,000 gallons of natural gasoline mixture against 32,935,000 gallons; 34,113,000 gallons of raw condensate against 36,563,000 gallons; 19,571,000 gallons of commercial butane-propane mixture against 21,856,000 gallons; 32,301,000 gallons of normal butane against 35,991,000 gallons; 21,735,000 gallons of propane against 25,029,000 gallons; 16,090,000 gallons of other liquefied petroleum gases against 17,474,000 gallons; 13,885,000 gallons of iso-butane against 14,374,000 gallons; 12,050,000 gallons iso-pentane against 13,075,000 gallons; 21,181,000 gallons finished gasoline and naphtha against 19,423,000 gallons, and 3,231,000 gallons of other products against 3,124,000 gallons.

Stocks declined more than three percent during the month, it was shown, those at plants and terminals dropping from 107,001,000 to 100,228,000 gallons while at refineries they increased from 97,650,000 to 98,154,000 gallons.

Russians Report Good Motor Fuel from Trees

An aviation gasoline component "twice as efficient as iso-octane" is being produced from turpentine in the U.S.S.R., it is reported in the Russian scientific literature, which is translated and reviewed by J. G. Tolpin, editor of Universal Oil Products Company's survey of foreign petroleum literature.

It is stated that this anti-knock compound, which is named "Uratol," resulted from the research of V. G. Plyusnin in the Ural division of the Academy of Sciences, and was produced in large-scale laboratory equipment as early as 1943.

The statement is made that turpentine also is employed to some extent as a regular motor fuel for trucks, tractors and other motorized equipment used in the lumber industry, although its principal present function seems to be to start engines which operate on producer gas.

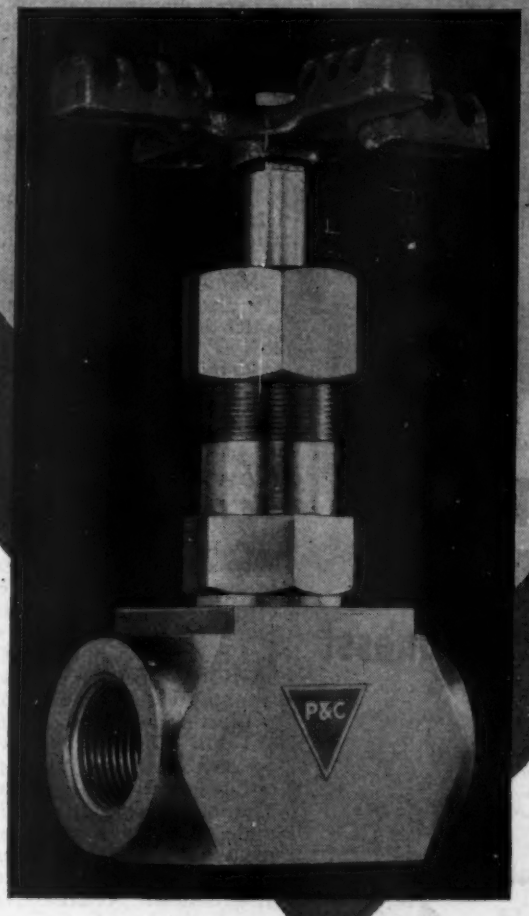
According to one author, the use of turpentine as a motor fuel presents considerable difficulty, particularly with respect to acidity and gum, and larger carburetor jets are necessary because of

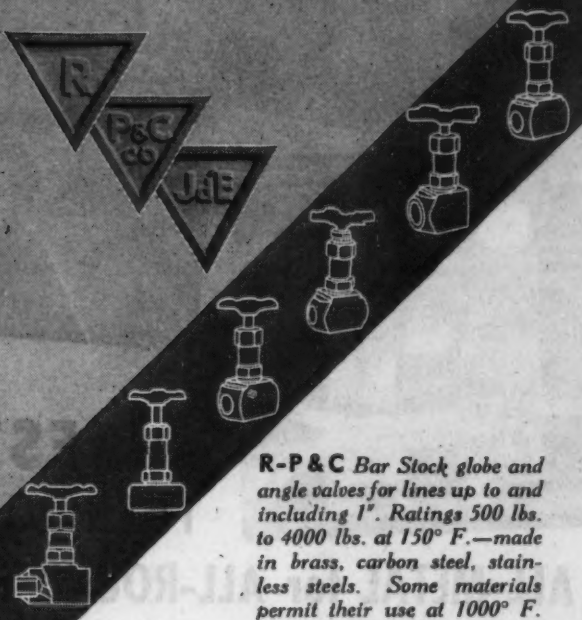
There's a *Story* behind this fine Valve

It is designed for severe throttling service. It is precision-made of rigidly controlled materials—for high working pressures. It is a Bar Stock valve—originated, developed and improved by **R-P&C** engineers. But that is only a part of the story.

This fine valve is one of a line that is still made under the "high working pressure" of wartime demands—in spite of the "severe throttling" of wartime shortages. And yet these Bar Stock valves are the best ever produced by **Reading-Pratt & Cady.**

It is a fact that **R-P&C** are making better valves today than ever before. We believe that's worth remembering next time you need valves.





R-P&C *Bar Stock globe and angle valves for lines up to and including 1". Ratings 500 lbs. to 4000 lbs. at 150° F.—made in brass, carbon steel, stainless steels. Some materials permit their use at 1000° F. (475 S.W.P.) Compact and sturdy for their ratings—low in price for their superior performance and long life.*

R-P&C offers you a single responsible source for bronze, iron and steel gate, globe, angle and check valves—cocks and Lubrotite gate valves—bar stock valves—cast steel fittings—D'Este Automatic Valves and Engineering Specialties.

READING-PRATT & CADY

MANUFACTURERS OF
READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

Reading, Pa. • Atlanta • Boston • Chicago • Denver • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Bridgeport, Conn.

ACCO

TRADE MARK

READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE

RELIABLE...readable

EVEN IN THESE *Rough Places*

WESTON THERMOMETERS

are ALL-METAL for ALL-ROUND ruggedness!

In tough spots like these, and many others too, *Weston All-Metal Industrial Thermometers* withstand shaking up without breaking down. Even the severe vibrations of pumping units or Diesel engines do not affect the long-term stability of Weston Thermometers.

Basic to their *all-round ruggedness* is an all-metal construction that insures sustained accuracy (within 1% full-scale) over long periods of time. There are no liquids, gases, capillaries or other troublesome parts. Simply an all-metal temperature element safely sheathed in a rugged stainless steel stem.

Weston All-Metal Thermometers are available in scale lengths 6", 9", 12" . . . stem lengths from 2½" to 48" . . ranges from − 100°F to + 1000°F. Literature gladly sent on request . . . Weston Electrical Instrument Corporation, 655 Frelinghuysen Avenue, Newark 5, New Jersey.

Weston *All Metal* THERMOMETERS

THE MONTH...

the higher viscosity of turpentine as compared to gasoline. Furthermore, means for preheating the fuel-air mixture to 60° C. are required. Another author, however, states that Soviet-made tractor engines designed for gasoline require no changes in order to burn turpentine.

At any rate, the reports make it clear that the possibilities of wider and more satisfactory utilization of turpentine as a motor fuel are being studied. Cracking of turpentine is one method being investigated.

Another product of research in wood chemistry is a lubricating oil made from wood-tar fractions. It is stated that more than 100 commercial units to produce such lubricating oils were under construction in 1943 in various parts of Russia.

These developments are the result of a campaign begun long before the war, and accelerated since 1941 to establish other sources of motor fuel and lubricants than petroleum, in various distant parts of the country where gasoline and lubricants could not be supplied, either because of shortage of petroleum or lack of adequate transportation.

Industries located in or beyond the Ural Mountains naturally turned their attention to their forests, which supply turpentine in abundance.

Numerous other by-products of wood are also being manufactured, some of which had previously not been made in Russia. Production of a synthetic resin from pine lignin and acetylene is presently in the development stage. Extensive research on the preparation of other new wood derivatives is going forward.

New York Headquarters Of Intava Organization

In preparation for the expansion of international aviation after the war, the Intava organization, which coordinates foreign aviation marketing activities of Standard Oil Company (New Jersey) and Socony-Vacuum Oil Company, Inc., interests, has moved its headquarters from London to New York.

Intava, Inc., owned equally by Standard Oil Company (New Jersey) and Socony-Vacuum Oil Company, Inc., was organized in 1944 to supplement the aviation petroleum activities originally undertaken by a group of aviation and technical petroleum experts established in London in 1936 under the name of International Aviation Associates, from which the brand name and trade mark "Intava" was derived.

This realignment makes the New York office of Intava, Inc., at 25 Broad Street the hub of a network of aviation petroleum marketing and servicing facilities in most foreign countries. The Intava service will thus enable an airline or private flyer to contract for aviation fuels, lubricating oils and special products anywhere outside of the United States and its possessions with the same ease as a private motorist used his credit card for travelling before the war.

Looking forward to the growth of aviation after the war, W. W. White, president of Intava, Inc., said: "Intava, Inc., believes that the future market for aviation petroleum products should be viewed from the standpoint that air

THE MONTH...

transport will henceforth wield an ever-increasing influence on the daily lives of almost everyone. It is therefore the aim of Intava, Inc., to assist Intava marketers to establish an efficient and complete petroleum service in all foreign areas and thus assure full participation in a new era of transportation, which, in importance to the oil industry, may prove equal to that of the development of the automobile."

All officers and directors of Intava, Inc., are from Standard Oil Company (New Jersey) or Socony-Vacuum Oil Company, Inc. The officers are W. W. White, president; Stanley Leigh, Shepard Dudley and C. H. Baxley, vice presidents; D. R. Brewer, secretary, and J. F. Seal, treasurer. The board of directors has been reconstituted as follows: J. W. Connolly, L. B. Levi, G. H. Michler, F. E. Powell, Jr., and Messrs. White, Leigh, Dudley and Baxley.

Plan South American Petroleum Congress Meet

At the third meeting of the International Permanent Council of the South American Petroleum Institute held recently in Buenos Aires, it was decided to hold the first South American Petroleum Congress in January, 1947, in Lima.

Public and private interests concerned with the industrialization and distribution of petroleum and its derivatives in South American and the United States, as well as institutions of learning and the active members of the I.S.A.P. will be invited.

The executive committee of I.S.A.P., with headquarters in Montevideo, as well as the Peruvian Section of I.S.A.P. with headquarters in Lima, will have charge of the organization of the congress, and the final details will be completed at a meeting of the International Permanent Council of South American Petroleum to be held in March, 1946, at Santiago, Chile, headquarters of the Chilean Section of the institute.

Socony-Vacuum Paraffin Emulsion Protects Fabrics

Socony-Vacuum Oil Company, Inc., has announced development of a wax emulsion for simple and economical application to fabrics to make them water repellant.

The emulsion is made up of minute particles of paraffin wax suspended in a solution of an aluminum salt and water, with as high as 40 percent wax to 1 percent of emulsifier, it was said.

R. C. Wheeler Dead

Raymond C. Wheeler, vice president, director and general manager of manufacturing for General Petroleum Corporation at Los Angeles, died August 19. He was 51. Wheeler had been with the company since 1918 in numerous executive posts. For many years he was manager of the company's natural gasoline department, and was a former president of California Natural Gasoline Association.

SPLIT-DUCT MANIFOLDING

Buell's assurance of HIGH EFFICIENCY, LOW MAINTENANCE, LONG LIFE

SPLIT-DUCT MANIFOLDING used in Buell (van Tongeren) Multiple Cyclones ensures *uniform* distribution of *both gas* and *dust* to the cyclone collectors. This method is most important to final collection efficiency. Uneven distribution can cause local recirculation of gas, resulting in greater erosion rates in the cyclones receiving the higher concentrations and in the impairment of collection efficiency. With Split-Duct Manifolding, a Buell design feature, maximum collection efficiency is attained by this uniform distribution of the gas load.

The outlet can be installed to discharge the cleaned gases from *any side* or *end*, a flexibility of arrangement that cannot be obtained with *unit chamber manifolding*.

Buell Dust Recovery Systems are designed to do a job, not just to meet a "spec". A promise fulfilled by Buell's high efficiency, long life and low maintenance in hundreds of installations throughout American industry.

BUELL FEATURES

SHAVE-OFF
LARGE DIAMETERS
EXTRA-STURDY CONSTRUCTION
CORRECT HOPPER DESIGN
SPLIT-DUCT MANIFOLDS
INNER WELDS GROUND SMOOTH

RESULT IN

HIGH COLLECTION EFFICIENCY
LESS FAN BLADE WEAR
LOW DRAFT LOSS
LOW POWER CONSUMPTION
HIGH TEMPERATURE RESISTANCE
UNLIMITED CAPACITY
NO MOVING PARTS
FREE DUST FLOW

PRODUCE

HIGH EFFICIENCY
LOW MAINTENANCE
LOW OPERATING COST
LONG LIFE
NO CLOGGING

buell
DUST RECOVERY SYSTEMS

JUST OFF THE PRESS: Buell's new revised book—*"The Buell (van Tongeren) System of Industrial Dust Recovery"*—now in its fourth printing, is just off the press. Write for your copy today.

BUELL ENGINEERING COMPANY, INC.
Suite 5000, 6 Cedar Street, New York 5, N. Y.
Sales Representatives in Principal Cities

DESIGNED TO DO A JOB, NOT JUST TO MEET A "SPEC"

A TWO-FOLD

Efficient Steam Generation

VU Steam Generator

3 VU Units outdoor type, installed at the Texas City Refinery of the Pan-American Refining Co.

Side elevation of VU Unit outdoor type, one of two for the Magnolia Petroleum Co., Chaison, Texas.

The C-E Steam Generator, Type VU, has found widespread acceptance among refinery engineers. VU Units with an aggregate capacity of over 9,000,000 lb of steam per hr have been purchased for a long list of refineries both in this country and abroad. The individual units range in size from 20,000 to 325,000 lb per hr capacity with pressures from 160 to 900 psi. Many of these VU installations are of the "outdoor" type — shown at the left — which appeal so naturally to an industry long accustomed to the practice of operating equipment in the open. Two of the principal reasons for the popularity of the VU Steam Generator are that it is a high efficiency design (up to 88%) and that it is capable of staying on the line continuously for a long time.

COMBUSTION

200 MADISON AVENUE

C-E PRODUCTS INCLUDE ALL TYPES OF STEAM GENERATING, FUEL BURNING

SERVICE TO THE REFINING INDUSTRY

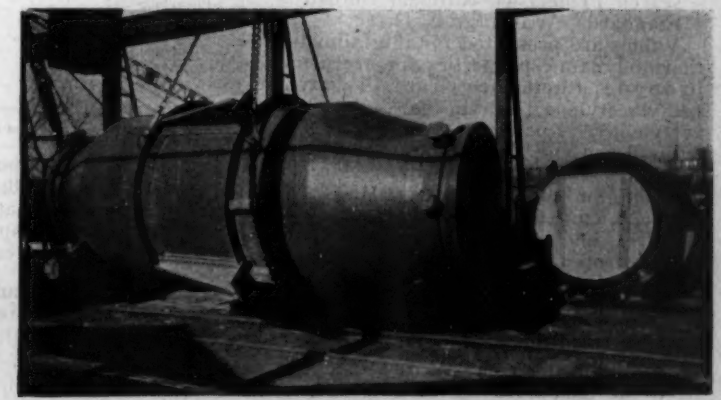
Dependable Pressure Vessels

Absorption tower for oil refining

As the fabrication of pressure vessels of various sizes and shapes necessitates manufacturing facilities and methods identical with those required for boiler manufacture, C-E is exceptionally well qualified for such production, from small classes of work to the largest and heaviest pressure vessels — simple or complex — and employing any type of carbon, alloy and clad steel. Especially notable are the C-E facilities for forming, machining, welding and X-raying heavy plate. With the improved methods and techniques developed to meet the unusual requirements of a large volume of war work Combustion Engineering is now better qualified than ever before to meet the most exacting pressure vessel specifications.

A-857-A

Bubble Tower — one of the largest and heaviest vessels of this type ever built. 13' 2" dia x 92' long x 2½" thick. Wgt. 490,000 lb.



Contactor for Aviation Gasoline. One of many built by C-E for various refineries. 95½" dia x 21' 6" long x ¾" thick. Wgt. 35,000 lb.

ENGINEERING

NEW YORK 16, N. Y.

AND RELATED EQUIPMENT; ALSO MANY TYPES OF PRESSURE VESSELS

Abstracts of Papers Presented by

Division of Petroleum Chemistry of the American Chemical Society Meeting in Print, 1945

Determination of Ethylene. A. W. Francis and S. J. Lukasiewicz, Socony-Vacuum Oil Company, Inc., Paulsboro, New Jersey.

Ethylene in gas mixtures is estimated by absorption with a solution of mercuric sulfate in 25 percent sulfuric acid. Since the absorption is irreversible, the reagent is preferred over a solution of silver sulfate in 72 percent sulfuric acid, which absorbs ethylene reversibly, and therefore gives low results after a few determinations with the same solution.

Determination of the Purity of Hydrocarbons by Measurement of Freezing Points. Augustus R. Glasgow, Jr., Anton J. Streiff, and Frederick D. Rossini, A.P.I. Research Project 6, National Bureau of Standards, Washington, D. C.

An improved and simplified procedure is described for determining the freezing points of hydrocarbons from time-temperature freezing and melting curves, and for calculating the purity when the freezing point for zero impurity is (a) known and (b) not previously known. A procedure for determining the cryoscopic constant is also described.

Assembly and Calibration of a Density Balance for Liquid Hydrocarbons. Alphonse F. Forziati, Beveridge J. Mair, and Frederick D. Rossini, American Petroleum Institute Research Project 6, National Bureau of Standards, Washington, D. C.

The assembly and calibration are described of a density balance for rapidly measuring the densities of liquid hydrocarbons on samples as small as 9 ml. in volume. The reproducibility of the measurements is ±0.00002 to ±0.00003 gram per ml. and the over-all uncertainty is estimated to be about ±0.00005 gram per ml..

Heats, Equilibrium Constants, and Free Energies of Formation of the Acetylene Hydrocarbons Through the Pentynes, to 1500° K. Donald D. Wagman, John E. Kilpatrick, Kenneth S. Pitzer, and Frederick D. Rossini, A.P.I. Research Project 44, National Bureau of Standards, Washington, D. C.

Values are presented for the following thermodynamic properties for acetylene, propyne (methylacetylene), 1-butyne (ethylacetylene), 2-butyne (dimethylacetylene), 1-pentyne (*n*-propylacetylene), 2-pentyne (methylethylacetylene), and 3-methyl-1-butyne (isopropylacetylene), in the gaseous state, to 1500° K: the heat content function, $(H°-H°_o)/T$; the free energy function, $(F°-H°_o)/T$; the entropy, $S°$; the heat content, $H°-H°_o$; the heat capacity $C°_p$; the heat of formation from the elements, $\Delta Hf°$; the free energy of formation from the elements, $\Delta Ff°$; and the logarithm of the equilibrium constant of formation from the elements, $\log_{10} Kf$.

Equilibrium constants and concentrations of components are given in tabular and graphical form for the isomerization of the two butynes and of the three pentynes as a function of temperature to 1500° K. Equilibrium constants are also given in tabular and graphical form for the dehydrogenation of ethane to ethylene to acetylene, of propane to propylene to acetylene, of n-butane to 1-butene to 1-butyene, and of *n*-pentane to 1-pentene to 1'-pentyne.

In order to comply with travel restrictions the American Chemical Society is holding its 1945 fall "meeting in print." These abstracts of the papers of the Division of Petroleum Chemistry are no departure with Petroleum Refiner, since it is the practice to print them when regular ACS meetings are held.

Boiling Point Relationships Among Mononuclear Aromatic Hydrocarbons. Nancy Corbin, Mary Alexander, and Gustav Egloff, Universal Oil Products Company, Chicago.

The variation of the boiling point with the number of carbon atoms has been determined for ten homologous series of mononuclear aromatic hydrocarbons. The equation for this relationship is in the form $t = a \log (n + 4.4) + k$.

The variation with the number of carbon atoms of the difference in boiling point between an aliphatic compound and its phenyl derivatives has been determined for nine homologous series. The equation for this relationship is in the form $\delta = k + a \log n$. A table of the values for a and k follows:

SERIES	Boiling Point		Boiling Point Difference	
	a	*k*	*a*	*k*
1. 1-Phenylalkane	712.38	—642.67	—150.209	272.57
2. 2-Phenylalkane	679.54	—614.40	—178.136	279.63
3. 1-Phenylalkene-1	537.36	—432.61	—204.460	318.22
4. 1-Phenylalkene-(n-1)	699.81	—632.26	—167.585	284.62
5. 1-Phenylalkyne-1	527.78	—411.31	—157.723	283.09
6. 1, 1-Diphenylalkane	406.87	—245.22	—223.926	425.24
7. 1-*n*-Diphenylalkane	617.38	—494.96	—216.155	441.76
8. 1, 1-Diphenylalkene-1	498.20	—358.25	—262.885	457.36
9. Phenylcyclane	776.30	—705.54	—150.209	272.57
10. *n*-Phenylmethane	576.27*	—377.16	.....	.....

* In this equation n was used instead of $n + 4.4$.

Comparisons have been made between phenylalkanes, phenylalkenes, and phenylalkynes; phenylalkanes and phenylcyclanes; 1- and 2- phenyl compounds, and monophenyl and polyphenyl compounds.

Correlation of Molecular Weights with Physical Properties for Petroleum Fractions. I. W. Mills, A. E. Hirschler and S. S. Kurtz, Jr., Sun Oil Company.

In this paper, molecular weights of petroleum fractions have been correlated with physical properties which are normally obtained as inspection tests for such fractions.

The correlations presented are of three types which, together, cover the ordinary range of petroleum fractions. They are as follows:

1. Molecular weight-boiling point-density for gasolines, kerosines and light oils, mol. wt. range 70 to 300.
2. Molecular weight-viscosity-density; and molecular weight vis $_{100}$ — vis $_{210}$ for oil fractions, mol. wt. range 240 to 680.
3. Molecular weight-refractive index (80° C.)—melting point for petroleum waxes, mol. wt. range 240 to 560.

The above correlations are shown to be in good agreement with most of the available data on petroleum fractions, and where applicable, with pure hydrocarbon data.

Surfaces of Solids. XVI. The Role of Capillary Condensation in Adsorption on Porous Solids and the Distribution of Pore Diameters. George Jura and William D. Harkins, University of Chicago.

Evidence is presented which demonstrates that poly-molecular films are formed on porous solids before capillary condensation takes place. In an extreme case the film reaches a thickness of over five layers before capillary condensation takes place.

A method is given by which the effect of structure of a porous solid on limiting the amount of gas that is adsorbed can be determined.

It is demonstrated that after a certain pressure, the effective adsorbing area of a porous solid decreases with an increase in pressure. A method is given by which the effective adsorbing area at any pressure can be estimated.

The values of γ and V to be used in the Kelvin equation are discussed and it is shown that the macroscopic values cannot be correct for the cases involved.

A distribution of the pore diameters on the basis of the Kelvin equation is given when all the possible corrections can be made: (1) change of area, (2) film thickness present, (3) volume adsorbed on unfilled pores, (4) correction for the density of the adsorbed film.

A method is presented which gives a pore distribution without the use of the Kelvin equation. The method is based on

STA-VOL-ENE the "Natural" known throughout the World, in Peace, as partner of the automobile, helped develop the transportation that is a vital part of the American-Way of life—in War it did more in helping preserve that freedom . . . . with the return of Peace, STA-VOL-ENE will contribute much to the many new developments forecast for tomorrow.

Hanlon-Buchanan, Inc

PIONEER NATURAL GASOLINE MANUFACTURER

EXPORT TERMINALS
Goodhope, La. Corpus Christi, Tex.
Houston, Texas Texas City, Texas
Boytown, Texas Galena Park, Texas

TULSA, OKLAHOMA
NATIONAL BANK OF TULSA BUILDING
PHONE 4-1101 or L.D. 358 WIRE — OR WRITE P. O. BOX 1559
Cable Address . . . STAVOLENE Tulsa, U. S. A.

FOREIGN REPRESENTATIVE
Barlis, Williams & Co., Ltd.
4 Lloyd's Ave.
London, England

the calculation of the mean pore diameter of the unfilled pores from the effective adsorbing area and the volume of the unfilled pores.

Freezing Points of the Nine Carbon Alkyl Benzenes. Multiple Crystalline Forms. A. E. Hirschler and W. B. M. Faulconer, Sun Oil Company.

All of the eight isomeric C_9 alkyl benzenes have been prepared in this laboratory. Freezing points, purities, densities, and refractive indices are reported in each case. Two freezing points were observed for *n*-propylbenzene, *o*- and *m*-ethyltoluenes, and pseudocumene; and three for mesitylene. In each case the freezing point of the pure hydrocarbon has been calculated; the results are believed accurate to 0.10° to 0.15° C.

For all of the above five instances of multiple freezing points, it is shown that no transitions between the known solid forms can exist; and the higher melting form will remain the only stable form at all temperatures below the melting point.

The existence of three stable crystalline forms of hemimellitene has been confirmed; and the transition points redetermined. Two metastable freezing points within 10° C. below the stable freezing points are predicted.

Quantitative Analysis of Hydrocarbon Mixtures by Means of Raman Spectra. E. J. Rosenbaum, C. C. Martin, and J. L. Lauer, Sun Oil Company.

After some discussion of the problems involved in an application of the Raman spectra method to the quantitative analysis of hydrocarbons, a simple and practical method requireing only elementary calculations is described. This method involves the photographing of the Raman spectrum of a sample under standardized conditions, microphotometering of the resulting negative, and reading of the densities of the analytically useful lines and their backgrounds from the microphotometer record. The method is calibrated in terms of a few known mixtures for each type of mixture to be analyzed. The analysis is obtained on a relative basis and thus requires either that all components of a mixture be determined by the Raman method or that the total fraction of the components which are determined must be known from some independent method. As examples of the types of results obtained, data are presented for the spectroscopic analysis of synthetic 3- and 4-component mixtures of known composition containing C_8 aromatics, various C_9 aromatics, and trimethylpentanes.

Pore Size Distribution in Porous Materials. I. The Pressure Porosimeter and Determination of Complete Macropore Size Distributions. H. L. Ritter and L. C. Drake, Socony Vacuum Oil Company.

In processes involving diffusion rates and surface availability, a knowledge of the total pore volume of porous materials is less important than a knowledge of the pore-size distribution. An experimental method is described for determining the distribution of macropore sizes in porous materials, based on the principle that pressure is required to force a nonwetting liquid into small pores. The mathematical technique for converting the experimental data into distribution curves is included as well as the derived distributions for several typical porous materials. Average pore radii calculated from the distributions are in agreement with those computed from volume/surface ratios.

Pore Size Distribution in Porous Materials. II. Macropore Size Distributions in Some Typical Porous Substances. L. C. Drake and H. L. Ritter, Socony-Vacuum Oil Company.

The macropore volume of some typical porous solids has been determined by means of a mercury porosimeter. These materials include: fuller's earth, bauxite, activated clays, fritted glass, activated alumina, diatomaceous earth, activated carbons, silica gel, silica-alumina gels, and porous iron. Pores with openings in the range 85,000 to 200 Å. in diameter are measured. It is shown that these materials exhibit a wide variation in their macropore size distribution, and that these differences may be related to other measurable physical properties, a number of which are included. Hysteresis was noted with most of the samples, and this has been related to pore shape.

Isomerization of Alkanes. I. Effect of Olefins Upon the Isomerization of n-Butane in the Presence of Aluminum Halide-Hydrogen Halide Catalyst. Herman Pines and R. C. Wackher, Universal Oil Products Company.

The isomerization of *n*-butane in the presence of aluminum chloride-hydrogen chloride and aluminum bromide-hydrogen bromide catalyst has been studied using high vacuum technique. It was found that under certain conditions paraffinic hydrocarbons do not undergo isomerization by means of aluminum halide-hydrogen halide catalyst unless a source of carbonium ions is present. Olefinic hydrocarbons have been found effective promoters for isomerization because they supply needed carbonium ion.

The effect of temperature and concentration of hydrogen chloride upon the degree of isomerization is given.

Isomerization of Alkanes. II. Effect of Oxygen Upon the Isomerization of n-Butane and n-Pentane in the Presence of Aluminum Bromide and Aluminum Chloride. Herman Pines and R. C. Wackher, Universal Oil Products Company.

The effect of oxygen upon the isomerization of *n*-butane and *n*-pentane in the presence of aluminum chloride or aluminum bromide has been studied using high-vacuum technique.

It was found that the addition of oxygen as air in concentrations of the order of 0.01 to 0.05 mole percent to *n*-butane or *n*-pentane is sufficient to cause isomerization; in the absence of oxygen under similar conditions the reaction does not proceed (Tables 1 and 2).

TABLE 1
Aluminum Bromide-Hydrogen Bromide Catalyst Temperature=25° C.

Mole percent *n*-butenes in *n*-butane charge	0	0.08	0.58
Percent Isobutane produced	0.2	19.3	65.6

TABLE 2
Aluminum Chloride-Hydrogen Chloride Catalyst Temperature=100° C.

Mole percent *n*-butenes in *n*-butane charge	0	0.013	0.05	0.09	0.28	2.49	5.22
Percent Isobutane produced	0.1	11.8	12.6	16.9	26.8	51.0	49.3

It has been shown that an aluminum bromide-oxygen-hydrocarbon complex formed by the action of air upon the solution of aluminum bromide in *n*-butane has a catalytic effect. It has also been shown that neither ethyl aluminum dibromide nor diethyl aluminum bromide either in the presence or absence of air has an effect upon the isomerization of *n*-butane.

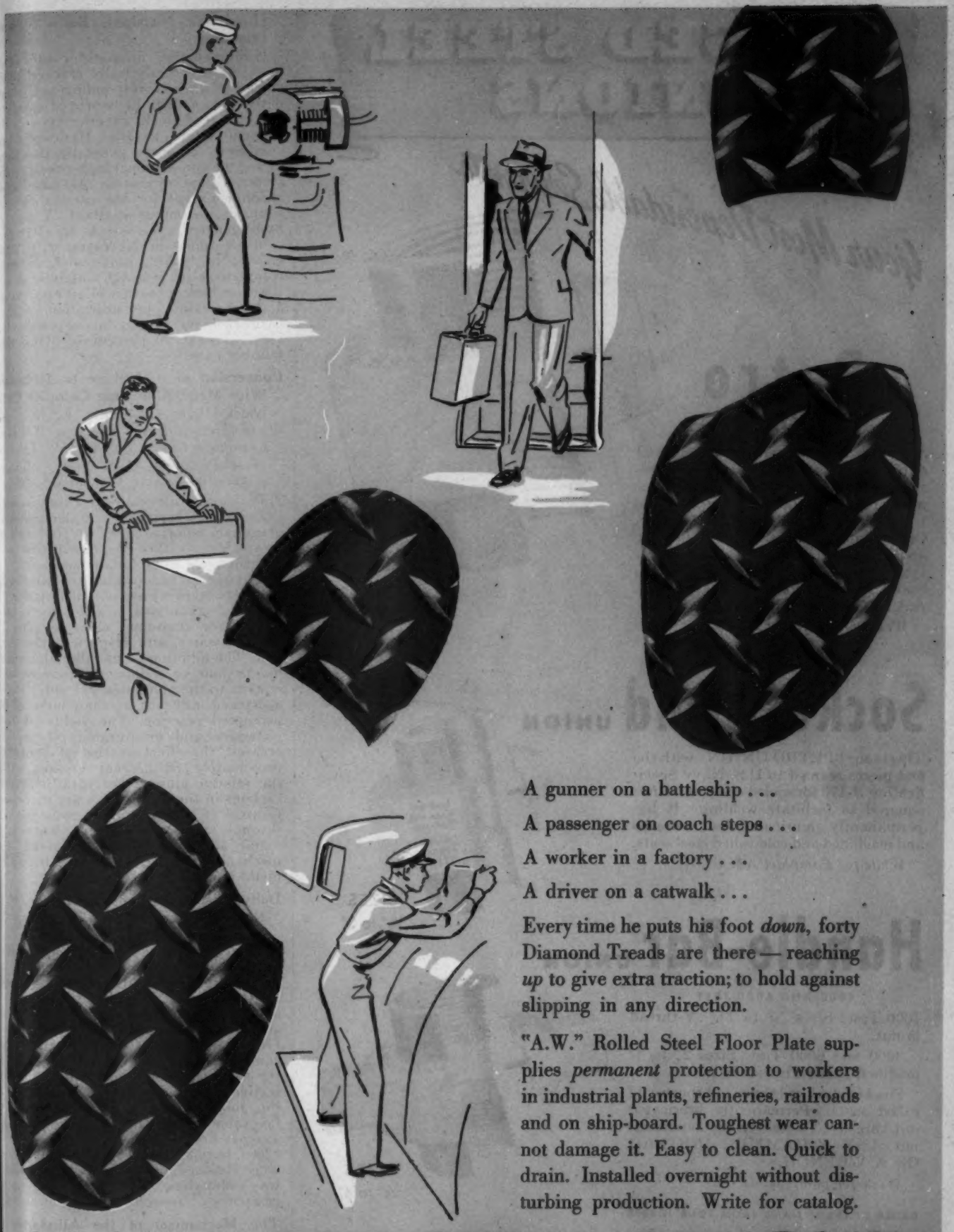
TABLE 1
Effect of Oxygen upon n-Butane and n-Pentane using Aluminum Chloride at 25° C.

	n-Butane			*n*-Pentane			
Experiment	5	6	7	1	2	3	4
Reaction time:							
Dark, hours	121	141	0	257	96	0	0
Sunlight, hours	0	0	16	0	0	9	12
Agitation	Yes	Yes	No	Yes	Yes	No	No
Reagents used, moles per 100 moles of alkane:							
$AlCl_3$	16.07	17.4	17.05	23.0	23.0	24.3	22.5
O_2 (as air)	0.0168	0.0196	0.0112	0	0.013	0.007	0.016
Analysis of product, mole percent:							
Isobutane	29.9	38.6	7.2	.....	48.3	11.5	40.9
n-Butane	70.1	59.0	91.3	.....	0.5	0	1.7
Isopentane	0	2.1	2.1	1.0	27.5	25.3	32.3
n-Pentane	0			99.0	7.3	59.5	11.8
Hexanes +	0			.....	16.4	3.7	13.3

TABLE 2
Effect of Oxygen upon n-Butane using Aluminum Bromide at 25° C.

Experiment—Reaction time:				
Dark, hours	500	97	139	102
Sunlight, hours	8	4	8	31
Reagents used, moles per 100 moles of *n*-Butane:				
$AlBr_3$	10.0	11.0	11.1	9.44
O_2 (as air)	0	0.06	0.044	0.055
Analysis of products, mole percent:				
Isobutane	0	9.5	39.7	63.6
n-Butane	99.5	90.1	59.0	35.0
Pentanes +	0.5	0.4	1.3	1.4

Hydrogenation and Desulfurization of Cycle Stocks from Catalytic Cracking C. L. Brown, Alexis Voorhies, Jr., and W. M. Smith, Esso Laboratories, Standard Oil Company of New Jersey



A gunner on a battleship . . .

A passenger on coach steps . . .

A worker in a factory . . .

A driver on a catwalk . . .

Every time he puts his foot *down*, forty Diamond Treads are there — reaching *up* to give extra traction; to hold against slipping in any direction.

"A.W." Rolled Steel Floor Plate supplies *permanent* protection to workers in industrial plants, refineries, railroads and on ship-board. Toughest wear cannot damage it. Easy to clean. Quick to drain. Installed overnight without disturbing production. Write for catalog.

ALAN WOOD STEEL COMPANY

SINCE 1826 :: CONSHOHOCKEN, PENNSYLVANIA :: District Offices and Representatives:
Philadelphia New York Boston Atlanta Buffalo Chicago Cincinnati Cleveland
Denver Detroit Houston St. Paul New Orleans Pittsburgh
Roanoke Los Angeles San Francisco Seattle Montreal

FORGED STEEL UNIONS

Your Most Dependable Servants

Petro UNION

America's most universally used Union! A partial list of proven services: Pressures from a vacuum to 3000 lbs. Temperatures from 100° below zero F. to 1000° above zero F. Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and all service in which Steel or Wrought Iron Pipe is used. Made to A.A.R. Standards and priced in line with 300 lb. A.A.R. Malleable Iron Unions.

Write for Pamphlet AM-67

SIZES
⅛" to 3"

Socket Weld UNION

This is our "PETRO UNION" with the end pieces reamed to U.S. Navy Specification B-173 for socket welding. Ends squared to facilitate welding. It has permanently lubricated nut threads and machined and cold rolled steel seats.

Write for Pamphlet AM-67.

SIZES
¼" to 3"

Handle-Bar UNION

4000 AND 6000 TEST

4000 Test: Sizes ⅜" to 1½" V-thread in nut.

4000 and 6000 Test: Sizes 2" to 4" modified Acme Threads in nut.

Steel to steel, or bronze to bronze cold rolled seats. Permanently lubricated nut threads. To tighten, or loosen the nut, USE A HAMMER INSTEAD OF A WRENCH.

Write for pamphlet 4P-HB.

SIZES
⅜" to 4"

ORDER BY TRADE NAME FROM YOUR JOBBER

ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS

CLAYTON MARK & COMPANY

1900 DEMPSTER STREET • EVANSTON, ILLINOIS

(Louisiana Division), Baton Rouge, Louisiana.

Hydrogenating aromatic constituents in refractory catalytically cracked cycle stocks to their corresponding naphthene derivatives results in improved catalytic cracking feed stocks superior even to the original virgin gasoils. Hydrogenation conditions used are generally the same as for the conventional high-pressure destructive hydrogenation of gasoils to gasoline except for the catalyst which, similarly, is sulfur-resistant. Yields of hydrogenated cycle stock are 100 percent or more in all cases with little change in boiling range and virtually complete sulfur removal. Catalytic cracking with hydrogenation of all cycle stock and recracking plus utilization of light hydrocarbons results in a volumetric yield of over 90 percent of 100-octane number gasoline.

Conversion of n-Heptane to Isobutane With Metal-Aluminum Chloride Catalysts. Oliver Grummitt, E. N. Case, present address, Sherwin-Williams Company, Chicago, and C. V. Mitchell, present address, U. S. Navy, Western Reserve University, Cleveland, Ohio.

Previous work on the cracking-isomerization of *n*-heptane by water-promoted aluminum chloride at 98° to 100° and atmospheric pressure has shown that a 78 percent yield of isobutane and a 22 percent yield of unsaturated oil (from the catalyst complex) are obtained under the optimum conditions of a 3/1 mole ratio of heptane/aluminum chloride plus 7.5 percent water with respect to the catalyst. The addition of metallic aluminum, magnesium, or sodium (50 percent with respect to the aluminum chloride) exerts a marked influence on the course of the promoted reaction. The yields of both isobutane and unsaturated oil are decreased, the effect on the oil being approximately 50 percent greater. Also, the relative amounts of paraffin hydrocarbons in the C_4-C_7 range are increased. Control of this reaction is thus possible through a combination of water and metal additions to the catalyst. The mechanism of the action of the added metal is discussed.

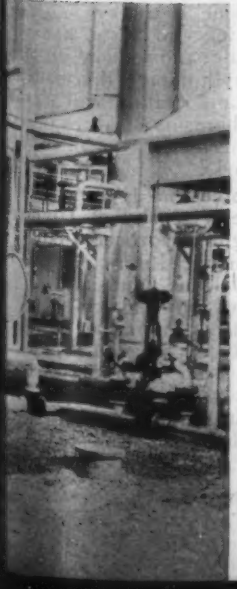
Dehydroisomerization of n-Butane. H. S. Bloch and R. E. Schaad, Universal Oil Products Company, Chicago.

The conversion of *n*-butane into a mixture of *n*-butylenes and isobutylene has been carried out at atmospheric pressure with a catalyst comprising a dehydrogenating component (chromia-alumina) and a olefinisomerizing component (silica-alumina-thoria). A catalyst bed composed of a mixture of granules of the two components was much more effective than was one of granules made of the mixed powders. Under the most favorable conditions (525° to 575° C., gaseous hourly space velocities of 500 to 1200), butylene yields of 25 to 30 percent were obtained, of which about one fourth was isobutylene, with a dehydrogenating efficiency of approximately 85 percent.

The Mechanism of the Alkylation of Paraffins. II. Alkylation of Isobutane With Propene, 1-Butene and 2-Butene in the Presence of Aluminum Chloride Catalysts. Louis Schmerling, Research Laboratories, Universal Oil Products Company, Riverside, Illinois.

The respective alkylates obtained by the reaction of isobutane with 1-butene

eatured in Haynesville Operators' Committee Plant



ONE of the most forward-looking practices in the petroleum industry is exemplified in the new plant of the Haynesville Operators' Committee, designed and built by Jones & Laughlin Supply Co., in Northern Louisiana, for the collection and processing of oil gas from the Haynesville field, and the return of the stripped gas for repressuring the oil-bearing area. In line with this ultra-progressive project is inclusion of ALCO Heat Exchangers.

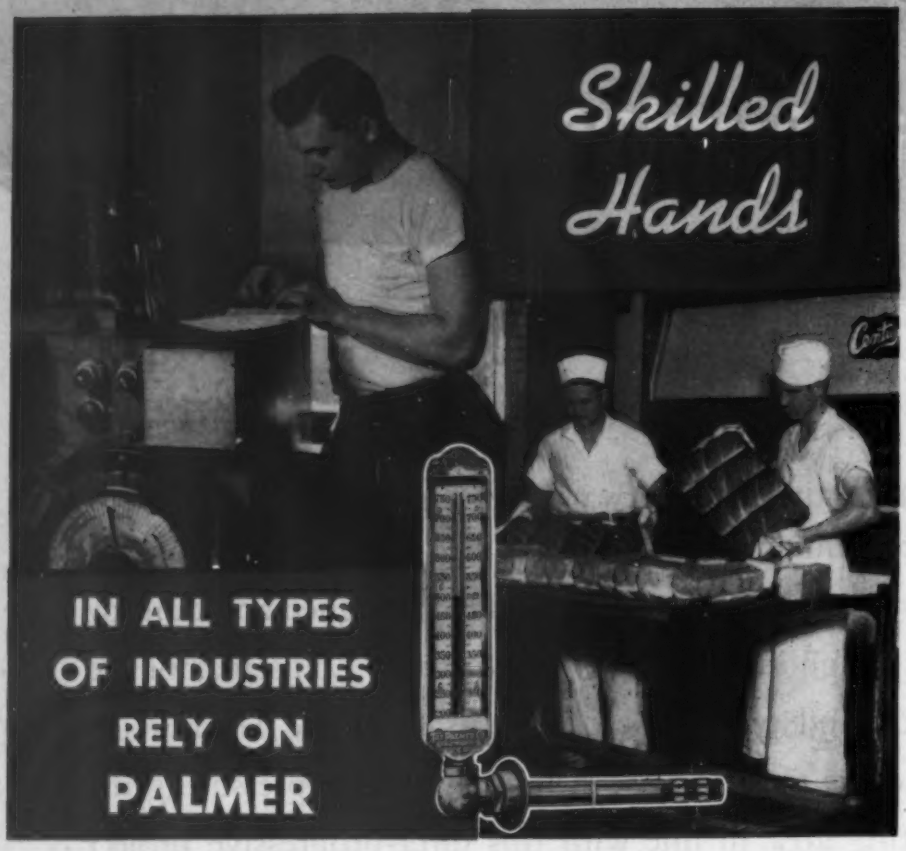
A very large proportion of all new plants built for the petroleum industry in recent years are equipped with ALCO-built units. The same is true of synthetic rubber plants, and many notable production units in the process industries.

ALCO engineers and shop men have the background, experience, and facilities, to design, build, and deliver, the heat exchangers, pressure vessels, and prefabricated piping, necessary to give you safe, efficient, and economical operation. We invite opportunity to show what ALCO can save you on any such project you may contemplate now or later.

American Locomotive

ALCO PRODUCTS DIVISION

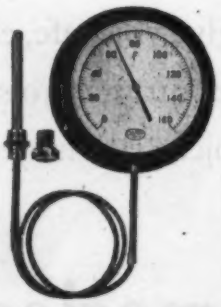
30 Church Street • New York 8, N. Y. • Plant: Dunkirk, N. Y.



PALMER "Red-Reading-Mercury" Thermometers are created by the skilled hands of Master Craftsmen, who produce Instruments for Temperature Indication and Recording that are dependably accurate . . . ALWAYS.

Leaders in practically all Industrial Fields, without exception, use PALMER Thermometers in the products they make. Easier reading, lower maintenance and rugged construction make them a basic part of many of the world's finest products.

Whether it is a "Red-Reading-Mercury" Industrial Thermometer, a PALMER "Superior" Recording or Dial Thermometer, engineers all over the world specify PALMER for accuracy and dependability.



Let us help you solve your Peacetime Temperature problems.

Write for Catalog

THE PALMER COMPANY

and with 2-butene in the presence of aluminum chloride monomethanolate and hydrogen chloride differed markedly, in that the former contained about 60 percent of dimethylhexanes and 10 percent of trimethylpentanes while the latter contain about 65 percent of trimethylpentanes and only 4 percent of dimethylhexanes. A similar difference in composition of the two products was observed when unmodified aluminum chloride was used as catalyst; the alkylation was, however, accompanied by more side reaction.

Alkylation of isobutane with propene using aluminum chloride monomethanolate as catalyst yielded a liquid product more than half of which was heptane and consisted of approximately equal amounts of 2,3- and 2,4-dimethylpentane.

The mechanism of the alkylation is discussed and the difference in composition of the butene alkylation products is explained on the basis of the recently proposed alkylation mechanism [J. Am. Chem. Soc., **66**, 1422 (1944)].

Hydrogen Fluoride-Paraffin Hydrocarbon Systems—Liquid Phase Equilibria and Their Significance in the Hydrogen Fluoride Alkylation Process. E. B. Butler, C. B. Miles, and C. S. Kuhn, Jr., Magnolia Petroleum Company, Dallas, Texas.

Mutual solubilities of low molecular weight hydrocarbons (isobutane, *n*-butane, and propane) and of hydrogen fluoride in two liquid phase systems, with and without water and alkylate, were determined for temperatures in the range 0 to 50° C., with alkylate concentrations up to 30 weight percent in the hydrocarbon phase, and with water contents up to about 10 weight percent in the acid phase. Anomalous solubilities of isobutane in the presence of alkylate and water are considered to be related to the greater alkylating activities of isoparaffins. Tentative correlations of the present data with analyses of plant streams are presented.

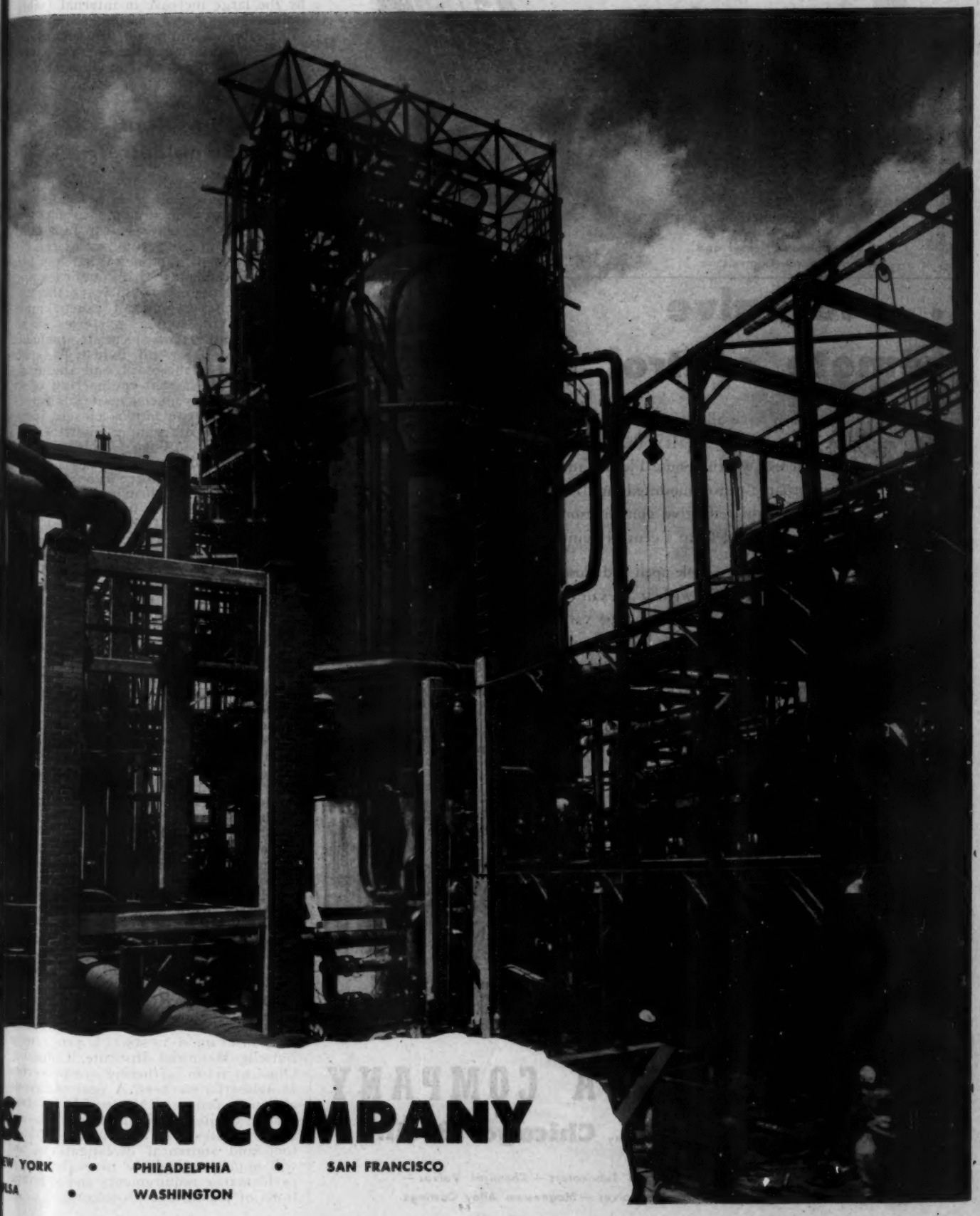
Alkylation of Alkanes. Gustav Egloff and George Hulla, Universal Oil Products Company, Chicago.

Seven alkylations with three normal alkanes (propane, butane, and hexane) and fifty alkylations with three branched alkanes (isobutane, isopentane, and 2,2,4-trimethylpentane) are discussed at length. Of these fifty-seven alkylations, seven use $AlCl_3$, four use $AlCl_3$ + alkali chloride, four use $AlBr_3$, one uses $AlBr_3$ + $AlCl_3$, one uses $ZrCl_4$, six use BF_3, eight use HF, twenty use H_2SO_4, and one uses H_3PO_4 as catalyst. Five alkylations are thermal reactions. Isobutane has been alkylated by fifteen alkenes, one alkadiene, four alkyl halides, one dialkyl sulfate, and two alkenyl chlorides. Isobutane and ethene yields mainly 2,2-dimethylbutane (thermally) or 2,3-dimethylbutane (catalytically, except H_2SO_4). Mechanisms of alkylations proposed by eight groups of investigators are presented.

Intermolecular Forces in Hydrocarbon Systems. I. The Viscosity of Higher Molecular Weight Hydrocarbons. A. Bondi, International Lubricant Corporation, New Orleans, Louisiana.

Viscosity data of pure hydrocarbons and lubricating oils of molecular weight 300+ and viscosity coefficients ranging up to 50 poises have been interpreted by means of Eyring's rate process theory of flow. The resulting energy and entropy parameters have been found to depend

. . for the modern refinery



& IRON COMPANY

EW YORK • PHILADELPHIA • SAN FRANCISCO

ILSA • WASHINGTON

HILLS-McCANNA *Diaphragm* Valve
(SAUNDERS PATENT)
with
Westinghouse Flexair and
Controlair Controls.

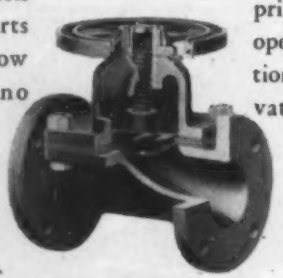
. . . to valve remote control problems

Now you can have all the advantages of a Hills-McCanna valve . . . plus operation by air. It's the answer to many valve remote control problems. Westinghouse Flexair and/or Controlair Controls and an air actuated piston mounted on a Hills-McCanna Diaphragm Valve, make up this effective combination . . . provide a reliable means of valve control from a central point in your mill or factory.

If your need is for a simple open and close valve operation, a Hills-McCanna unit, equipped with a Flexair Control, may solve your problem. And where a throttling type valve is required, Controlair Controls and a Hills-McCanna Diaphragm Valve and Piston operation, will help meet your want. Whether it's Flexair or Controlair-equipped you get smooth, air operation over a wide range.

Since all installations include an auxiliary air tank as part of the design, there's power to operate the valve even if the main air supply or all other power should fail.

And remember, Hills-McCanna Diaphragm Valves are absolutely leakproof, control the flow and keep unwanted material out of the line, won't clog or stick . . . have working parts isolated from the flow . . . and require no packing.



Write for the fact-packed blueprint that describes the operation and installations of this air activated valve.

Available in sizes ranging from 4" to 12" inclusive.

HILLS-McCANNA COMPANY

2441 W. Nelson St., Chicago 18, Ill.

Proportioning Pumps — Force Feed Lubricators — Chemical Valves — Air and Water Valves — Marine Valves — Magnesium Alloy Castings

more on the spatial arrangement of the hydrocarbon molecule than on the nature of the chemical bonds within the molecule. Comparison of viscosity-pressure and viscosity-temperature relationships suggests that the high viscosity of complex hydrocarbons is only partly due to intermolecular forces (expressible as a function of the energy of vaporization), the remaining portion being contributed by the large increase in internal (vibrational) energy and entropy required by the activated molecule to accomplish crossing of the potential energy barrier in the path of a particle moving from one equilibrium position to the next.

Many Firms Kept Atom Bomb Secret

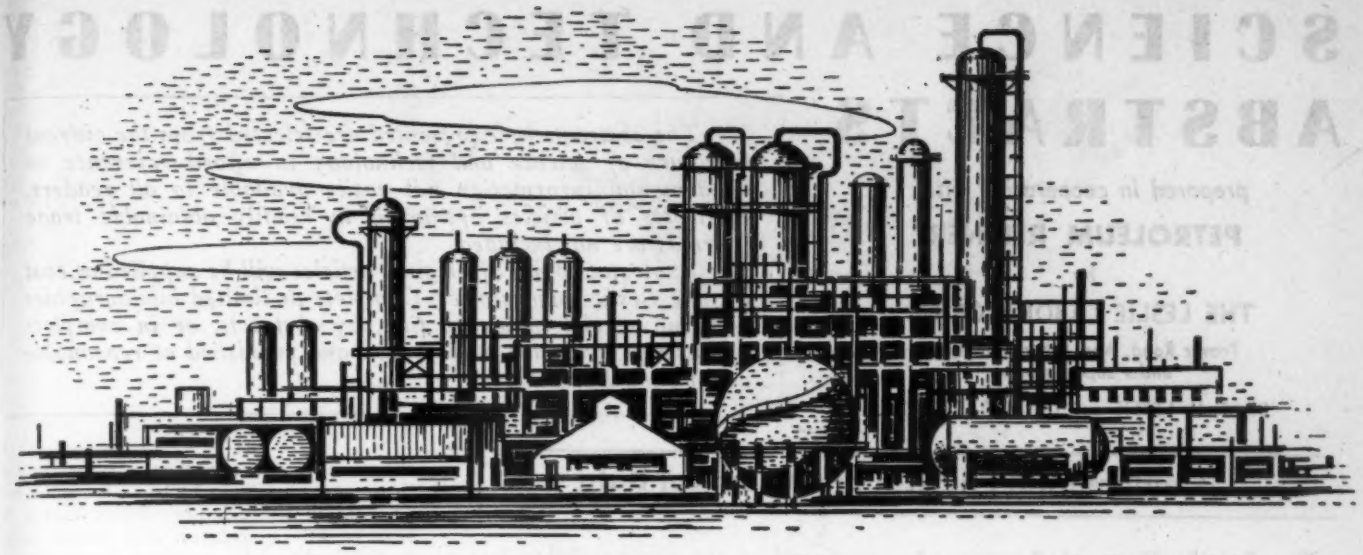
Announcement by President Truman August 6 of certain details of development of the atomic bomb used so effectively in the war against Japan partially lifted the veil from one of the best kept secrets of all time. What has been revealed indicates that publication of completest details would leave the matter still a secret to all except minds trained in the higher mysteries of science. Hundreds of scientists, including personnel of the oil industry's staffs, contributed to the work, and among the leaders in the actual engineering of the plants which produced materials for the bomb were organizations closely identified with the oil-refining industry.

The M. W. Kellogg Company organized a subsidiary, Kellex Corporation, which built up a large organization for engineering and construction work on the Oak Ridge plant in Tennessee. Kellogg, along with Carbide and Carbon Chemicals Corporation, Bell Telephone Laboratories, Bakelite Corporation, Monsanto Chemical Company, Hooker Electrochemical Company, E. I. du Pont de Nemours & Company, Harshaw Chemical Company, and many others contributed to early investigations, building of pilot plants, etc. Design and construction of the plant involved contributions from Westinghouse Electric Corporation, General Electric Company, Allis-Chalmers Manufacturing Company, Stone & Webster Engineering Company, Taylor Instrument Companies, and others. The Washington plant was built and operated by E. I. du Pont de Nemours & Company.

Such secrecy attended the work on the bomb that no complete list probably could be compiled of the scientists and engineers who had a part in it. Key officials of some of the companies working on the project were not all advised of what was under way, and many manufacturers were called upon to make items which fitted into the machinery who did not know for what purpose the parts were intended.

Eye-Safety Research

American Society of Safety Engineers is sponsoring a research program at Battelle Memorial Institute, Columbus, Ohio, to aid in furthering eye protection of industrial workers. A year of investigation is proposed to provide information to combat eye injuries in American industry. Research will include laboratory and statistical investigations, and will apply particularly to evaluation of performance requirements and specifications of plastic eye protectors.



FABRICATION... Both BY B&W

Part of a de-hydrogenation unit in a butadiene plant, these catalyst cases comprise the world's largest special alloy steel tubing job—over eleven hundred tons of intricate, process equipment for high-temperature service—much of it stainless.

Another in the long line of B&W "firsts", this project demonstrates again the broad scope of B&W's facilities and service.

B&W not only built these gigantic labyrinths, but also produced every foot of the 27% and 7% chromium alloy tubes used in their construction. B&W engineers further contributed to the efficiency of this unique equipment by suggesting, from their broad experience, several valuable simplifications of the original design.

You can bring *tube* problems to B&W with confidence of getting the right answers. The experience B&W has gained in producing enough pressure tubing to circle the Earth five and one-half times, plus the unrivaled B&W research and testing facilities, plus modern specialty tube mills combine to give you tubes matched to jobs for dependability, long life and economy.

You can bring to B&W, with equal assurance, the most complex problems of *design* and *fabrication* of pressure vessels, tanks, drums, towers, piping, and other high-pressure, high-temperature equipment.

No technical problem is too difficult, no fabricating job too complicated for B&W when it comes to providing tubing and process equipment for today's exacting needs.

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
85 LIBERTY STREET • NEW YORK 6, N. Y.
THE BABCOCK & WILCOX TUBE COMPANY
SEAMLESS TUBE DIVISION, BEAVER FALLS, PA. • WELDED TUBE DIVISION, ALLIANCE, OHIO

S-54T

SCIENCE AND TECHNOLOGY ABSTRACTS

prepared in cooperation with

PETROLEUM REFINER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Michigan
under supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

The Specific Heats of Gaseous 1,3-Butadiene, Isobutene, Styrene, and Ethylbenzene. R. B. Scott and Jane W. Mellors. *J. Res Natl. Bur. Standards* **34** (1945) pp. 243-54 (Res. Paper No. 1640).

The specific heats of 1,3-butadiene and isobutene were measured between —35 and 80° C. and those of styrene and ethylbenzene at 100° C. were measured in a flow calorimeter. The apparatus is described in some detail. The values of the specific heats in the ideal gas state in cal./mole degree at the temperatures given are: 1,3-butadiene, —35.0°, 15.74; 0.0°, 17.66; 40.0°, 20.03; 80.0°, 22.25; isobutene, —34.0°, 18.13; —1.0°, 19.81; 39.0°, 21.91; 80.0°, 23.96; styrene, 100°, 36.16; ethylbenzene, 100°, 38.06.

Phase Equilibria in Hydrocarbon Systems. H. H. Reamer, R. H. Olds, B. H. Sage, and W. N. Lacey. *Ind. & Eng. Chem.* **37** (1945) pp. 688-91.

The widespread occurence of carbon dioxide in natural gas mixtures from petroleum reservoirs makes desirable a more complete knowledge of carbon dioxide-hydrocarbon systems. The literature contains few data. The work reported in the present paper represents the second of a series of investigations on this general subject and cover volumetric behavior of ethane-carbon dioxide system. Five mixtures of ethane and carbon dioxide were studied with respect to their volumetric properties in the temperature interval from 100° to 460° F. at pressures up to 10,000 pounds per square inch. The results are tabulated in detail in terms of compressibility factors and molal volumes. The results are also presented in graphical form.

Empirical Correction for Compressibility Factor and Activity Coefficient Curves. R. A. Morgen and J. H. Childs. *Ind. & Eng. Chem.* **37** (1945) pp. 667-71.

In determining the compressibility factor z and activity coefficient f/p, correction factors for the law of corresponding states are indicated. Ethylene and nitrogen are used as the references, and the curves of z vs. P_R and f/p vs. P_R are given for these gases. A chart is given that shows a positive correction factor for those gases ($T_R > 1$) for which the reciprocal of the compressibility factor at the critical point, ($1/z_c$) is 3.35 or less. The correction factor can be neglected for those vapors ($T_R > 1$) for which the reciprocal of the compressibility factor at $1/z_c$ is 3.35 or less. A chart is given that shows a negative correction factor for those gases ($T_R > 1$) for which the reciprocal of the compressibility factor at $1/z_c$ is 4.0 or greater. This chart shows a positive correction factor for those vapors ($T_R > 1$) for which the reciprocal of the compressibility factor at $1/z_c$ is 4.0 or greater. For those compounds whose $1/z_c$ values are between 3.35 and 4.0, the curve for z and f/p for ethylene and nitrogen should be used with the knowledge that values drift in the direction indicated by the correction factors.

Chemical Compositions and Reactions

The Analysis of Trinidad Crude Oils. II. The Paraffinic Oils. F. Morton and A. R. Richards. *Jour. Inst. Petr.* **31** (1945) pp. 159-72.

Crude oils of Trinidad consist of two main types, a paraffinic oil yielding, on distillation, a naphtha of the paraffin-aromatic type, and a naphthenic oil yielding a naphtha of mixed naphthenic type. The present paper deals with the analysis of 14 individual crude oils from 4 different areas. The analytical methods used are briefly described, and the results are presented in some detail in tabular and graphical form. The results obtained were not such as to make possible any theoretical deductions as to the reasons for the differences observed, and it can only be stated with certainty that the paraffin aromatic oils of Trinidad, although of one type, exhibit fundamental differences throughout the producing areas examined.

Diagnostic Characteristics of Crude Oil: Fluorescence Analysis in Ultraviolet Light. J. N. Mukherjee and M. K. Indra. *Jour. Inst. Petr.* **31** (1945) pp. 173-78.

The authors describe a method of distinguishing between oils by means of fluorescent analysis in ultraviolet light. The subject of distinguishing between crude oils of different origin is briefly reviewed. The methods used in the work are described, including fluorescence quenchers, the spot test, capillary analysis, and chromatography. The results obtained in the course of the work are given, and they are of the opinion that it may be possible to develop a method for distinguishing types of crude oil.

The Chemistry of Acetylene. J. A. Nieuwland and R. R. Vogt. Reinhold Publishing Corp., New York, N. Y., 1945.

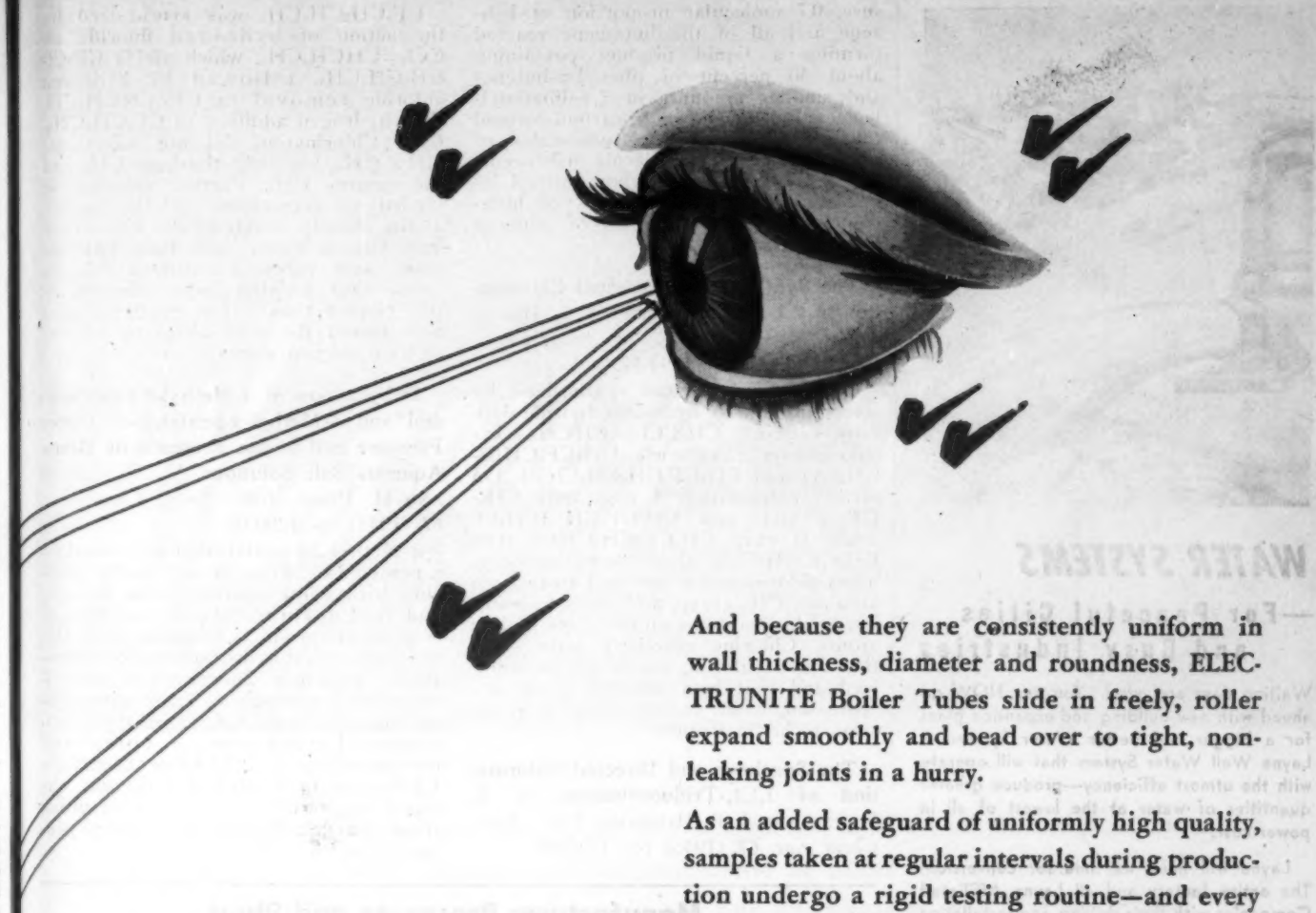
This book, published as A.C.S. Monograph No. 99 includes five chapters dealing with the preparation and physical properties, metallo-derivatives, substitution reactions, addition reactions, and polymerization or condensation reactions of acetylene. Each chapter is subdivided into approximately ten parts, with a bibliography at the end of each part. References are thus kept close to the subject matter.

Conversion of Aromatics. R. C. Hansford, C. G. Myers, and A. N. Sachanen. *Ind. & Eng. Chem.* **37** (1945) pp. 671-75.

The conversion of alkylaromatic hydrocarbons in the presence of a typical petroleum cracking catalyst under conditions similar to those encountered in commercial catalytic cracking and reforming operations was studied. Xylene was converted to toluene and trimethylbenzenes by disproportionation of methyl groups. Trimethylbenzenes were converted to toluene, xylene, and polymethylbenzenes, and methylnaphthalene was converted to naphthalene and polymethylnaphthalenes by the same mechanism. Diethylbenzene was converted to ethylbenzene and ethylene; no triethylbenzenes were detected in the reaction products. In the presence of benzene, alkyl groups from alkylbenzenes are transferred to this hydrocarbon with the formation of higher yields of monoalkylbenzene than in the disproportionation reaction. Methyl groups are not, however, transferred from methylnaphthalene to benzene.

Reaction Between Benzene and Butadiene in the Presence of Silico-phosphoric Acid Catalyst. V. N. Ipatieff, R. E. Schaad, H. Pines and G. S. Monroe. *Jour. Amer. Chem. Soc.* **67** (1945) pp. 1060-62.

On passing a 4.5:1 molecular mixture of benzene and butadiene through a layer of silico-phosphoric acid catalyst at 216° C. and at 27 atmospheres pres-



● Inside and outside, you are assured of clean, scale-free surfaces throughout every length of Republic ELECTRUNITE Boiler Tubes.

Why? Because ELECTRUNITE Boiler Tubes are cold formed from flat-rolled steel, both sides of which are open to close visual inspection.

But that's not all! There are other reasons why it pays to use Republic ELECTRUNITE Boiler Tubes.

These *modern* boiler tubes speed up retubing. They are free from hard spots—are uniformly high in ductility—because they are full normalized throughout their entire length.

And because they are consistently uniform in wall thickness, diameter and roundness, ELECTRUNITE Boiler Tubes slide in freely, roller expand smoothly and bead over to tight, non-leaking joints in a hurry.

As an added safeguard of uniformly high quality, samples taken at regular intervals during production undergo a rigid testing routine—and every tube is subjected to a hydrostatic pressure, well in excess of code requirements, before it leaves the factory.

ELECTRUNITE dependability is proved by the fact that more than 150,000,000 feet have been installed in all types of steam generating and heat transfer equipment throughout industry.

For more information about ELECTRUNITE Boiler Tubes and the Electric Resistance Weld Process by which they are made, write for your copy of our new brochure.

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

Republic
ELECTRUNITE
BOILER, CONDENSER AND HEAT EXCHANGER TUBES

WATER SYSTEMS

—For Peaceful Cities and Busy Industries

Waiting days are over! You can NOW go ahead with new building and expansion plans for a bigger and better Water System—a Layne Well Water System that will operate with the utmost efficiency—produce greater quantities of water at the lowest of all in power cost.

Layne will need no time for conversion! The entire factory and all Layne Affiliated Companies with their drilling and installation crews are ready — and now are in action building Well Water Systems for all types of industries, cities, villages, mines, and irrigation projects.

You will want your new well water system to embody the many outstanding and exclusive Layne features. You will want the Layne ruggedness of quality that insures longer life and the Layne unmatched high efficiency for low operation cost.

Better write—or wire for full details of Layne's all inclusive Well Water Development service. For catalogs, address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

LAYNE PUMPS *— fulfill every need for producing large quantities of water at low cost from wells, streams, mines or reservoirs. Send for literature.*

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. * Layne-Atlantic Co., Norfolk, Va. * Layne-Central Co., Memphis, Tenn. * Layne-Northern Co., Mishawaka, Ind. * Layne-Louisiana Co., Lake Charles, La. * Louisiana Well Co., Monroe, La. * Layne-New York Co., New York City * Layne-Northwest Co., Milwaukee Wis. * Layne-Ohio Co., Columbus, Ohio * Layne-Texas Co., Houston, Texas * Layne-Western Co., Kansas City, Mo. * Layne-Western Co. of Minnesota, Minneapolis, Minn. * International Water Supply Ltd., London, Ontario, Canada * Layne-Hispano Americana, S. A., Mexico, D. F.

LAYNE

WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

sure, 0.7 molecular proportion of benzene and all of the butadiene reacted forming a liquid product containing about 50 percent of phenyl-n-butenes and smaller amounts of 1,4-dibutenylbenzene, a dicyclic hydrocarbon formed by interaction of two molecules of butadiene with one molecule of benzene, and a tricyclic hydrocarbon formed by interaction of two molecules of butadiene with two molecules of benzene was also formed.

The Synthesis and Directed Chlorination of 2,2-Difluorobutane. A. L. Henne and J. B. Hinkamp. *Jour. Amer. Chem. Soc.* **67** (1945) pp. 1194-97.

$CH_3CF_2CH_2CH_3$ was synthesized by interaction of dry hydrogen fluoride with commercial $CH_3CCl=CHCH_3$. Its chlorination gave only CH_3CF_2CHCl-CH_3(A) and $CH_3CF_2CH_2CH_2Cl$(B). On further chlorination A gave only CH_3-$CF_2CCl_2CH_3$ and $CH_3CF_2CHClCH_2Cl$, while B gave $CH_3CF_2CH_2CHCl_2$ then $CH_3CF_2CH_2CCl_3$ almost exclusively. Thus chlorination is directed away from an alpha CH_3 group, and tends to introduce chlorine atoms on the same carbon atoms. Chlorine reactivity tests show that alpha chlorine atoms are immobilized and that beta chlorine atoms are repressed, while gamma chlorine atoms seem to be unaffected.

The Synthesis and Directed Chlorination of 1,1,1,-Trifluorobutane. A. L. Henne and J. B. Hinkamp. *Jour. Amer. Chem. Soc.* **67** (1945) pp. 1197-99.

$CF_3CH_2CH_2CH_3$ was synthesized by the action of hydrogen fluoride on $CCl_3=CHCH_2CH_3$, which yields CF_3Cl-$CH_2CH_2CH_3$, followed by hydrogen chloride removal to $CF_2:CHCH_2CH_3$, then hydrogen addition to $CF_3CH_2CH_2$-CH_3. Chlorination did not affect the alpha CH_2, but only the beta CH_2 and the gamma CH_3. Further chlorination tended to accumulate on the carbon atoms already affected. The CF_3 group immobilized alpha and beta chlorine atoms and repressed a gamma chlorine atom, thus proving more effective in this respect than a CF_2 group; it also accentuated the acid character of the alpha hydrogen atoms.

Dehydration of 2-Methyl-2,4-pentanediol and 4-Methyl-x-penten-2-ol Under Pressure and in the Presence of Dilute Aqueous Salt Solutions. V. N. Ipatieff and H. Pines. *Jour. Amer. Chem. Soc.* **67** (1945) pp. 1200-02.

2-Methyl-2,4-pentanediol and 4-methyl-x-penten-2-ol were heated under pressure with dilute aqueous ferric chloride and magnesium chloride solutions. Among the products resulting from this reaction certain hydrocarbons were identified, including 2-methyl-1,3- and 4-methyl-1,3-pentadiene, 1,3,5-trimethylcyclohexene and 1,3,5-trimethyl-5-isopropenyl-1-cyclohexene. A compound corresponding to 2,2,4,4,6-penta-methyl-1,3-dioxane in a yield of 2 percent was found among the products resulting from the dehydration of 2-methyl-pentanediol with iodine.

Manufacture: Processes and Plant

Fluid Catalysts Make Their Debut in Chemical Production. J. A. Lee. *Chem. & Met. Engr.* **52** (1945) pp. 100-101.

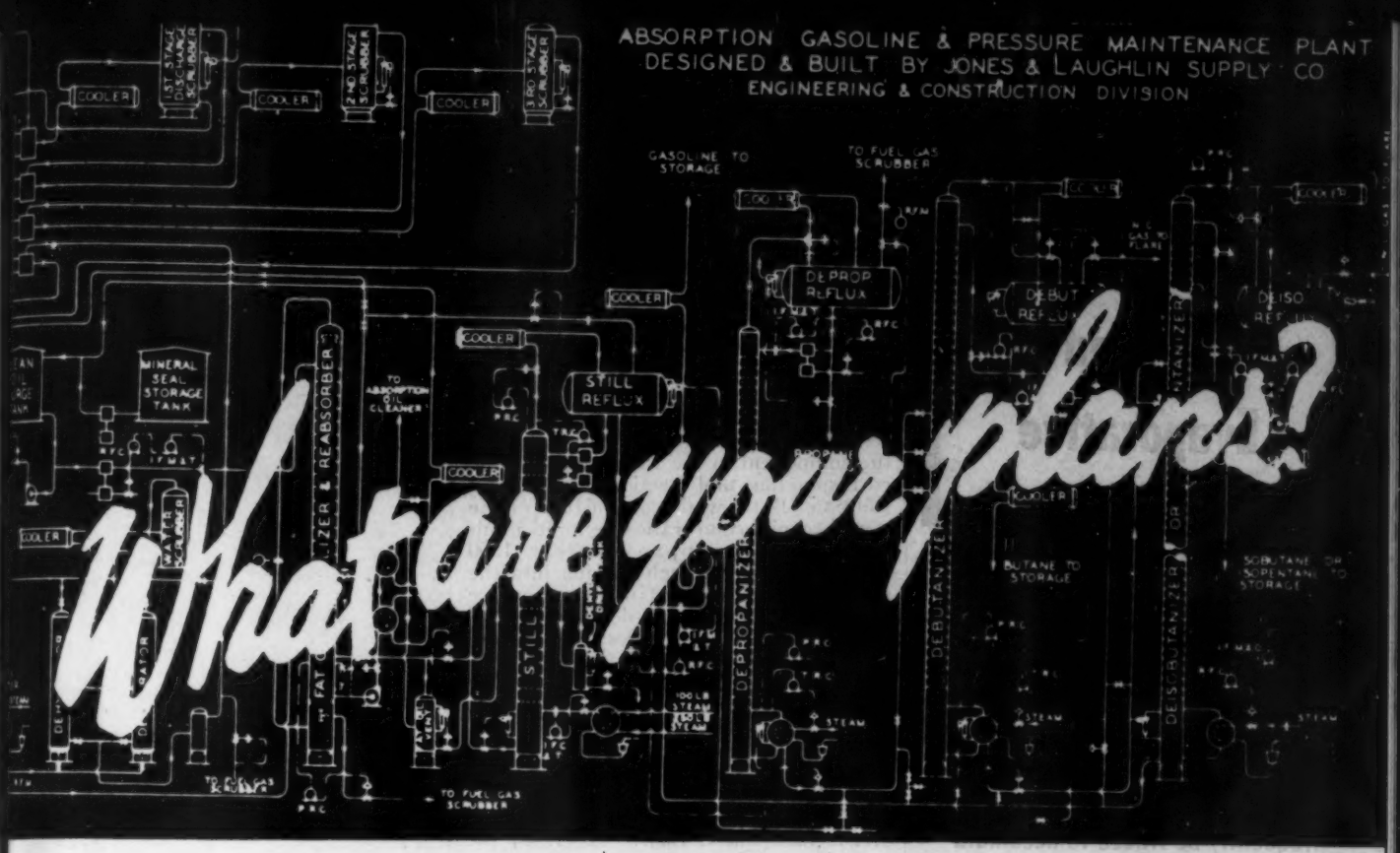
Since the introduction of fluid catalyst technique into petroleum refining many organizations have been investigating means for adapting it to chemical processing. This has been successfully done in the production of phthalic anhydride, and the activation of naphthalene to phthalic anhydride with the aid of a fluid catalyst represents the first commercial successful application of this technique in the chemical industry. Possibly the principal advantage of the process is in the high purity of product which averages 99 percent phthalic anhydride. This purity is caused by uniform contact between catalyst and reactants and the consequent ability to operate at lower temperatures than in fixed-bed operation. The fluid-catalyst process is safer from the standpoint of explosions. Less labor is required per unit of product. No buildings are required except that for control room, catalyst plant, and air compressors. All other equipment is located outdoors as in petroleum refineries. The process and the catalyst are described.

Recovery of Toluene from Petroleum by Azeotropic Fractionation. G. R. Lake. *Trans. Amer. Inst. Chem. Engrs.* **41** (1945) pp. 327-52.

In the early stages of the war it became evident that the supply of toluene available from coal tar would not be sufficient to permit exportation of toluene as well as to supply the domestic demands. The estimated requirement was 85,000,000 gallons for 1940, and the production in sight only 28,000,000 gallons. The paper summarizes investigations undertaken to evaluate various organic compounds as azeotrope formers for the separation of toluene from nontoluene hydrocarbons of roughly the same boiling points. The data presented show that the methyl ethyl ketone-water azeotrope is the best azeotrope-former of all those tested. A small continuous pilot plant was operated as a means of securing data for the design and operation of a commercial plant. A summary is given of the results obtained in the course of a study of the principal process variables. Nitration grade toluene was prepared from several widely different stocks by the MEK-water azeotropic process.

Experimental Determinations of the Vapor-Liquid Equilibria Between Natural Gas and 95 Percent Diethylene Glycol Up to a Pressure of 2000 psi. G. F. Russell, L. S. Reid, and R. L. Huntington. *Trans. Amer. Inst. Chem. Engrs.* **41** (1945) pp. 315-25.

The investigation is related to the dehydration of natural gas by diethylene glycol. It was undertaken because of the need for equilibrium data for use in the design and operation of high-pressure absorption plants. A review of the literature failed to reveal any relevant information that would allow calculation of the equilibrium conditions for water and glycol in natural gas under high


ABSORPTION GASOLINE & PRESSURE MAINTENANCE PLANT
DESIGNED & BUILT BY JONES & LAUGHLIN SUPPLY CO
ENGINEERING & CONSTRUCTION DIVISION
What are your plans?

John Public is not yet sure what sort of gasoline and motor oil his new car will require, nor what changes and improvements in other refined products will be included in the luxury of post-war living. But he means to enjoy them to the utmost. You can't blame him for that.

And so a sensible analysis of technical and process problems are now in order. Your products must, at reasonable cost, meet specifications and demands imposed by post-war conditions.

Our long experience in refinery construction, plus our more recent role in design and construction of facilities for the manufacture of aviation combat fuel, have kept us in the forefront of refinery development.

Engineering and Construction Division

JONES & LAUGHLIN SUPPLY COMPANY

TULSA, OKLAHOMA

Slime & Scale Controlled in Evaporative Condensers

In many cases, decreased operating efficiency of evaporative condensers or evaporative coolers can frequently be traced to accumulations and deposits of slime and scale on coil surfaces.

A new, specially designed Oakite material . . . Oakite Airefiner No. 52 . . . now provides today's most successful answer to this problem. Inexpensive to use and highly effective, Oakite Airefiner No. 52, added to water supplies in sump tank, combats and inhibits formation of slime on coils and eliminator plates due to its germicidal and fungistatic properties. In addition, it retards and helps prevent formation of lime scale deposits on spray nozzles and coil surfaces.

Free Service Report Gives Details

Send for FREE Service Report describing safe-to-use, non-toxic Oakite Airefiner No. 52. No obligation, of course!

OAKITE PRODUCTS, INC.
508 Thames Street, New York 6, N.Y.
Technical Service Representatives Located in All Principal Cities of the United States and Canada

pressures. The investigation covers a study of vapor-liquid equilibria for a 95-percent-by-weight diethylene glycol in contact with natural gas at pressures ranging from atmospheric to 2000 pounds per square inch at a temperature of 100° F. A concurrent vapor-liquid contactor was used for the dynamic mixing of natural gas with a glycol-water solution. The total water and glycol vapor content of the natural gas was determined by absorption in anhydrous magnesium perchlorate. The glycol vapor was absorbed separately in distilled water. The water vapor content was calculated by difference. The equilibrium data are presented as a ratio of the mol fraction of the component in the vapor phase to the corresponding mol fraction in the liquid solution. Both water and diethylene glycol equilibrium ratios exhibit minimum values at approximately 1500 pounds per square inch passing into the retrograde condensation range above this pressure. A rapid decrease in dehydration efficiency at pressures exceeding 2000 psi is indicated.

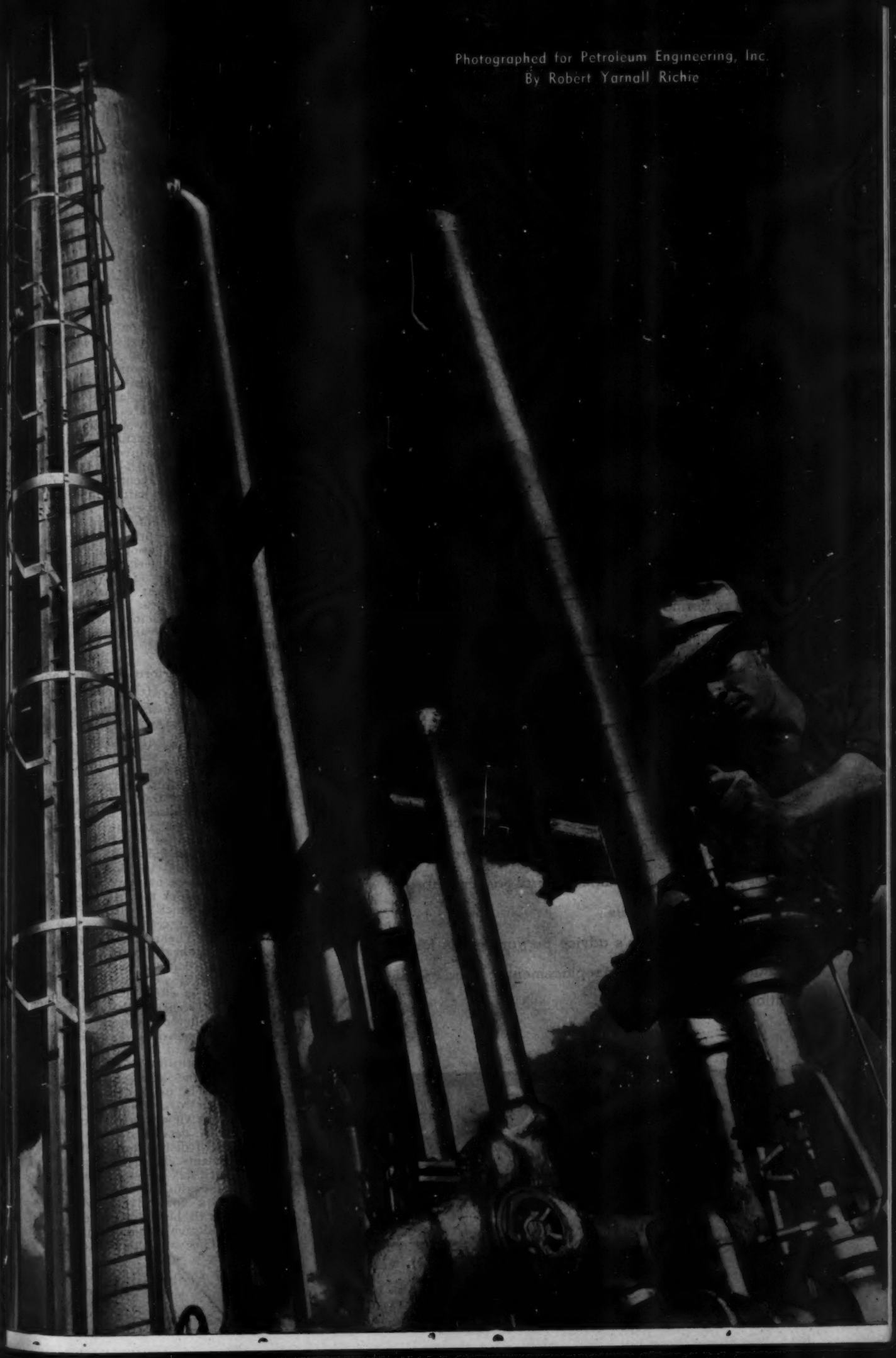
Extractive and Azeotropic Distillation. II. Separation of Toluene from Paraffins by Azeotropic Distillation with Methanol. M. Benedict, C. A. Johnson, E. Solomon, and L. C. Rubin. *Trans. Amer. Inst. Chem. Engrs.* **41** (1945) pp. 371-92.

The phase relationships controlling separation by extractive distillation are illustrated by an experimental study and a theoretical analysis of liquid-vapor equilibrium in the system n-heptane-methanol-toluene. Experimental data are presented for the systems n-heptane-methanol, toluene-methanol, and n-heptane-methanol-toluene, at atmospheric pressure. The general thermodynamic conditions for liquid-vapor equilibrium at low pressures are expressed in terms of activity coefficients, which are derived from the excess free energy of mixing. The excess free energy of mixing is correlated by a power series in mol fractions of the components in the liquid phase. Adequate representation of experimental data in the system n-heptane-methanol-toluene was secured by using fourth powers of mol fractions. A systematic procedure for evaluating coefficients in this power series from experimental activity coefficients by the method of least squares is described. The equation for the ternary mixture n-heptane-methanol-toluene contains 12 independent constants. Three of these are evaluated from data on each of the three binary mixtures n-heptane-methanol, n-heptane-toluene, and methanol-toluene. The three constants remaining are evaluated from data on the ternary mixture. By means of the equation, charts are prepared for relative volatilities in mixtures of methanol, toluene, and a hypothetical paraffin of the same vapor pressure as toluene. These charts are used to calculate the characteristics of a tower for separation of toluene from this hypothetical paraffin by extractive distillation with methanol.

Extractive and Azeotropic Distillation. I. Theoretical Aspects. M. Benedict and L. C. Rubin. *Trans. Amer. Inst. Chem. Engrs.* **41** (1945) pp. 353-70.

In both extractive and azeotropic distillation a solvent not present in the mixture to be separated is added to in-

One of numerous gas processing plants designed and constructed by Petroleum Engineering, Inc. during its 16 years of service to the industry. *Petroleum Engineering, Inc. Offices: Tulsa and Houston.*

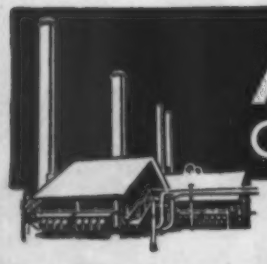


Photographed for Petroleum Engineering, Inc.
By Robert Yarnall Richie

Smooth performance of Alcorn heaters is backed by 21 years of experience in designing and building installations for major refineries all over the world.

Alcorn *custom built* heaters have been furnished for a wide capacity range up to 100,000,000 B.T.U. per hour; and for every pressure and temperature. Peak production and low operating costs have resulted invariably. Alcorn *standardized* heaters with capacities ranging from 8,000,000 to 40,000,000 B.T.U. are adapted for topping units, re-run units, natural gasoline, absorption, and recycling units.

Why not let Alcorn's advice be your guide for the building of new units or replacements? Send specifications now.



ALCORN
Combustion Company
SCHAFF BUILDING, PHILADELPHIA
Los Angeles • Houston • San Francisco

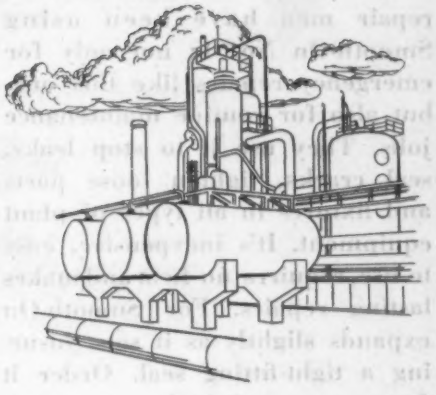
crease the difference in volatility between the key components. To be effective, the solvent must be present in appreciable concentration in the liquid phase on most of the trays of the column. The types of distillation differ in the means used to secure useful solvent concentrations. In extractive distillation, the solvent is less volatile than the key components; it is charged near the top of the column, and some is necessarily removed with the bottoms. In azeotropic distillation, the solvent forms a constant-boiling mixture with one or more of the key components, and some is necessarily removed with the overhead. Graphical and algebraic methods of establishing the changes in solvent and key component concentrations from tray to tray in each type of distillation are described. In extractive distillation, the distribution of solvent throughout the column is determined by heat and material input as in a conventional absorber. In azeotropic distillation, distribution of solvent throughout the column is determined largely by phase relationships in mixtures of solvent and key components. The principal advantages of extractive distillation are: (1) the heat input for a given separation is lower because solvent is not taken overhead; (2) more solvents are available because the precise nature of phase relationships in mixtures of solvent and key components is not critical to success of the process. The principal advantages of azeotropic distillation are: (1) when the proportion of overhead is small, less solvent is required; (2) in batch processes, all the solvent required may be charged to the still at the beginning of the distillation. Factors affecting the choice of solvent in each type of distillation are described.

Design and Performance of Cooling Towers. W. K. HUTCHISON AND E. SPIVEY. *Proc. Chem. Engr. Group of Soc. Chem. Ind.* **24** (1942) pp. 14-29.

Investigations of the performance of cooling towers of standard design, including chimney draught and forced draught types, were correlated on a basis of the heat transfer in unit time and on unit cross-section of the cooling tower, in relation to the inlet water temperature and to the degree of approach to the wet-bulb temperature. The empirical relations derived from this correlation may be found of value, within the limits for which they were developed, in obtaining a quick estimate of the size of cooling tower required for any particular duty. Theoretical treatment of the problem indicates that the performance of any cooling tower can be expressed accurately in terms of a single mass transfer coefficient which can be used for the calculation of results lying outside the range of experimental verification. The conclusion was reached that the performance of the tower can be improved by substitution of smooth boards on edge for the triangular bars commonly used. The method of distribution of the water over the packing was studied with a view to avoiding entrainment. It was decided that a multiple trough type of distributor would satisfy the requirements. The efficiency of fans normally used has been examined in the course of the studies, and it was concluded that a correctly designed propeller fan with blades of true aerofoil section would give a considerable saving in power. This was confirmed experi-

Specially suited for refinery service

Oliver Fasteners



Because of the exacting requirements of refinery applications, your interests are best served by *specialized* fasteners. Knowing this, Oliver offers machine bolts, stud bolts, rivets and other headed and threaded products that will withstand the high temperature, corrosion, high stresses and other conditions that would shorten the life of ordinary fasteners.

Use our specialized knowledge and facilities in selecting and specifying your fasteners!

OLIVER
IRON AND STEEL
Corporation
SOUTH TENTH AND MURIEL STREETS • PITTSBURGH, PA.

SMOOTH-ON No. 1 SAVED COST OF NEW STEAM CHEST

This crack occurred in one of the worst possible spots in the casting, where steam pressure would have forced the crack wide open. The engineer first filled the crack tightly with Smooth-On No. 1 Iron Repair Cement, then bolted on an angle plate and reinforced it with supporting bands. The repair proved lasting, and the cost of a new high pressure steam chest and reassembly was saved.

For 50 years, engineers and repair men have been using Smooth-On No. 1; not only for emergency repairs like this one, but also for routine maintenance jobs. They use it to stop leaks, seal cracks, tighten loose parts and fixtures in all types of plant equipment. It's inexpensive, easy to use, requires no heat and makes lasting repairs. For Smooth-On expands slightly as it sets, insuring a tight-fitting seal. Order it from your supply house — sizes from 7-oz. up—and keep it handy. If your supplier hasn't it, write us.

FREE FAMOUS REPAIR HANDBOOK

Over 1,000,000 now in circulation. Full information for making repairs of countless types. 40 pages. 170 diagrams. Clear, concise directions. Fits the pocket—and should be in YOUR pocket. Send coupon for your copy.

— — — Do It NOW — — —

Smooth-On Mfg. Co., Dept. 11,
570 Communipaw Ave.,
Jersey City 4, N. J.
Please send me MY Smooth-On Repair Handbook.
Name.....
Address.....
9-45 .....

1895-1945 Half a Century of Dependable Service

Do it with **SMOOTH-ON**

mentally. Several commercial towers have been designed and built on the basis of the studies reported, and show complete agreement with the results obtained in the experimental unit. Approaches of 1°-4° F. to the wet-bulb temperature are shown to be practicable in towers of moderate size.

Gas Adsorption Methods for Measuring Surface Area of Adsorbents. P. H. EMMETT. *Ind. & Eng. Chem.* **37** (1945) pp. 639-44.

Within the last 10 years, several new approaches to the problem of measuring the absolute surface areas of both porous and nonporous solids have been made. The purpose of the author's paper is to summarize published methods with a view to assessing their relative usefulness and general applicability. Methods for measuring surface areas by gas adsorption may, for convenience, be divided into two groups. The first group is based upon the postulate of the existence of multilayers of physically adsorbed gas and makes use of adsorption isotherms of gases near their boiling points. The second group assumes that the adsorption of a vapor is a combination of monomolecular physical adsorption and of capillary condensation. The author concludes that the use of low-temperature adsorption of some gas, such as nitrogen, near its boiling point is the best substantiated procedure thus far described, and that this procedure is capable of yielding reliable values for the surface areas of porous and finely divided materials or even of materials that have relatively small surface areas.

Some Chinese Clays as Adsorbing Agents. T. J. SUEN AND F. H. YAO. *Jour. Inst. Petr.* **31** (1945) pp. 179-87.

Chinese clays in their natural form, and also activated, were studied to determine their usefulness in decolorizing and degumming oils. The Tsunyi halloysite proved to be the most active among the clay samples studied. Its gum-reducing capacity was particularly impressive. After 30 distillations it was still useful for degumming. It was noted that the decolorization of individual oil samples was considerably affected by temperature. For gasoline moderate temperature was best. For lubricating oils temperatures of 180-200° C. were better than lower temperatures. It is sometimes considered that a clay with a high ratio of silica to alumina has great adsorbing power. However this was not found to be true of the Chinese clay. For degumming it was found that one ton of clay would degum at least 12,000 gallons of gasoline.

Polyisobutylene Tank Lining. D. W. YOUNG AND W. C. HARNEY. *Ind. & Eng. Chem.* **37** (1945) pp. 675-78.

Various manufacturing processes require noncorrosive ducts, containers, storage tanks, and vessels in which a wide variety of chemical reactions are conducted. Much work has been devoted to the development of corrosion-resistant linings for such containers. Various types of plating have been used. Recent developments make use of high-molecular-weight synthetic thermoplastic protective agents. The use of polyisobutylene has depended upon the development of a feasible method for binding the polymer to the metal. A successful method has been devised, and tests on polyisobutlyene-coated metal specimens indicate that this method can now be used in commercial applications for a wide variety of corrosive liquids and gases. A process for the manufacture of high-molecular weight polyisobutylene compositions is described, as well as the method of bonding the materials to steel. The adhesion of the polymer film to steel is approximately 700 pounds per square inch at room temperature. High loadings of carbon black produce good adhesion or interlocking of this linear type-polymer to steel when cyclized rubber cement is applied as an intermediate bonding agent. Data are given showing the resistance of the lining to concentrated and dilute solutions of acids and alkalies at room temperature. Except in a few instances the compounded polymer linings showed no tendency to blister at 100° C.

Products: Properties and Utilization

CFR Handbook, 1944 Edition. New York: J. J. Little & Ives Co. 290 pp. $4.50.

The test methods and procedures as developed by the Coordinating Fuel Research Committee are presented. Part I, on Aviation Fuels, includes inspection tests and specifications, evaluation of knocking characteristics by laboratory lean-mixture method and by a recommended procedure for rating fuels in full-scale engines, determination of vapor-locking tendency and its relation to fuel characteristics. Part II, on Motor Fuels, includes inspection tests and specifications, CFR Research Method and CFR Motor Method for the laboratory evaluation of knocking characteristics; CFR procedures for determination of octane-number requirement of vehicles on the road, antiknock quality of fuels on the road, effect of spark timing on engine power, maximum power and knock tests on dynamometer and chassis dynamometer; testing the starting characteristics of motor fuels; vapor lock in ground vehicles; National gasoline surveys, 1936-1943, and motor survey, 1940. Part III, on Automotive Diesel Fuels, includes inspection tests, classifications, CFR method of test for ignition quality, test procedure for full-scale Diesel engine with summary of 1942 progress report. A bibliography is appended.

Acidity in Transformer Oil. A. LATHAM. *Elec. Times* **105** (1944) pp. 772-73.

The use of activated alumina for the removal of acidity from transformer oil is critically discussed. Reconditioning oil by this method resulted in the reduction of acid value from 3.65 to 2,35 mg. of KOH/g, the weight of alumina being 8.75 percent of that of the oil. Treatment of used alumina by burning, washing with paraffin, or drying with air at 500-600° C. proved unsatisfactory. In view of the difficulty and expense of the procedure it is suggested that oil should not

be removed from the transformer until corrosion of the metal is observed. New oil should then be introduced and activated alumina placed in bags on the top of the windings to counteract any tendency toward an increase in acidity owing to old oil remaining in the cores and laminations.

Properties of Asphalt Made from Athabaska Bituminous Sands. A. A. SWINNERTON. *Can. Bur. Mines, Mines & Geol. Branch, Memo Ser. No. 88* (1944) 17 pp.

Two samples of crude bitumen from Athabaska obtained from different locations were found to attain softening points of 110-200° F. when heated by the use of fire and steam. The yield was 93-37 percent by volume. The products that softened at 110° F. were oxidized until the softening point was changed to 120-300° F. From the inspection of the oxidized products it is concluded that they are familiar to products obtained from various crude oils, and that it would be feasible to process the Athabaska bitumen to any required consistency and hardness.

Loss Effects and Equilibration Times for Packed Fractionating Columns of High Efficiency. E. A. COULSON. *Jour. Soc. Chem. Ind.* **64** (1945) pp. 101-4

Many laboratory batch fractional distillation columns having the equivalent of 50 to 100 theoretical plates are coming into general use. Certain inherent and peculiar properties are readily over-

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, Illinois, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

2-Methyl-1-pentene
2-Methyl-2-pentene
3-Methyl-2-pentene
Divinyl ketone
Divinyl sulfide
4-Hydroxybutanone-2
Anthraquinone-1-, 5-disulfonic acid
2, 6-Dimethyl aniline
Phenalone
n-Amyl thiourea
Sorbic acid
o-n-Propyl benzoic acid
p-n-Propyl benzoic acid
p-Isobutyl benzoic acid
Thiamorpholine
cis Hexahydro terephthalic acid or methyl esters
trans Hexahydro terephthalic acid or methyl esters
cis Hexahydro isophthalic acid or methyl esters
cis Hexahydro phthalic acid or methyl esters
trans Hexahydro isophthalic acid or methyl esters
Dodecyl phenol (any)
3-Hydroxy-o-toluic acid
p-Amino benzyl alcohol
Pure normal paraffins over thirty-six carbons
Phorone (200 lbs)

Here's why

AIRETOOL

TUBE CLEANERS & EXPANDERS

SAVES TIME — SAVES TUBES — SAVES MONEY

New Form Cutters

New Form Cutters are precision made of special heat treated alloy steels for prolonged usage. Designed to remove severe deposits in tubes quickly and efficiently without tracking. Made in a variety of styles and sizes.

Driven By More Powerful Motor

Airetool Tube Cleaners are driven by a power seal motor that develops up to 28% more power. Can be loaded down to 50 rpm. without stalling. Has slip fit construction for easy maintenance. For tube sizes ½" to 24" I.D., straight or curved.

Tough Tube Expanders

Airetool Tube Expanders are made of heat treated alloy steels for greater endurance. No tube expanding job is too tough for them. Many styles and sizes.

HELPFUL BULLETINS

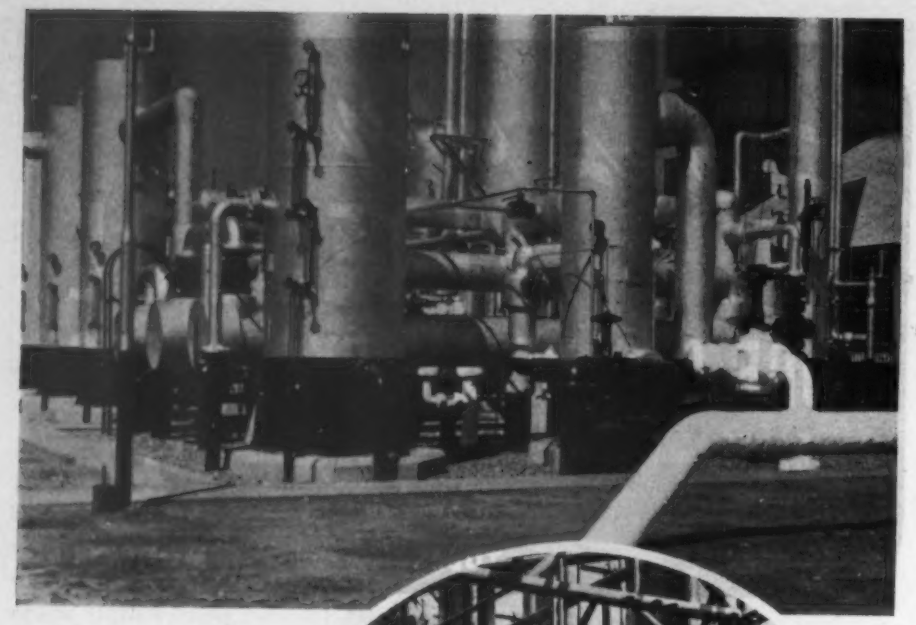
are available which explain Airetool products. Write for your copies.

DEPT. R

Airetool & Yost-Superior Factory Bldgs.

SPRINGFIELD, OHIO

AIRETOOL MANUFACTURING COMPANY



HAERING GLUCOSATES

control

CORROSION, SCALE and ALGAE in the PETROLEUM INDUSTRY

Write on your letterhead for "ECONOMICS OF WATER CONDITIONING"

WE READ WATER

D. W. HAERING & CO., Inc.

GENERAL OFFICES:

205 West Wacker Drive, Chicago 6, Ill.

looked by workers unfamiliar with this type of apparatus, and for this reason performance may fall far below the best of which the apparatus is capable. Two such factors are: (a) the effect of slight losses of liquid or vapor at the still-head, and (b) the time required for the development of the full separating efficiency of the column. The effect of losses, either by incomplete vapor condensation or through ground-glass joints, is discussed and specimen calculations are given. A simplified mathematical treatment, whereby the time required for the equilibration of an efficient batch column can be calculated to a first approximation from the operating characteristics as commonly determined, is developed and applied to a series of 50- and 100-plate columns.

Glass Helices for Packing Fractionating Columns. I. DOSTROVSKY AND T. R. JACOBS. *Chem. & Ind.* **26** (1945) pp. 204-5.

The authors describe a method for making glass helices for packing fractionating columns. Although not automatic, the method is rapid, and possesses the advantage of great simplicity. It can be applied by unskilled persons for the production of either ⅛-inch or 1/16-inch spirals made of soft or Pyrex glass. The apparatus used is described in some detail. Approximately 24 spirals 11 inches long can be wound per hour. The method of breaking the long spirals into single turn helices is identical with that previously described by Still.

Book Review

Cast Iron in the Chemical and Process Industries

Gray Iron Founders' Society, Cleveland, Ohio, or Washington, D. C. 28 pages. Price $1.00.

Extensive data on the corrosion rates of cast iron exposed to the action of substances commonly handled by chemical structures feature this pamphlet, the work of F. L. LaQue, head of the corrosion-engineering section of The International Nickel Company.

Results of laboratory and plant tests with more than 300 corrosive media in an alphabetical range from acetic acid to zinc sulfate are shown. The four appended tables also list the many chemicals regularly handled by cast-iron pumps and valves and those resisted satisfactorily by high-silicon irons.

Factors dictating cast irons for corrosive service, the availability of the material, design for chemical-industry equipment and many specific applications are discussed. Pointing to the corrosive-service-per-dollar factor, the booklet states that in some applications the nature of the corrosive media is such that, despite a fairly rapid attack on cast iron, no other material can be expected to render long enough service to justify a higher initial cost.

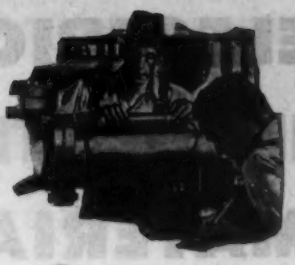
Differences in the manner in which cast iron resists corrosion, the pamphlet notes, are related directly to the structure of the material and, particularly, to the presence of graphite flakes in a ferritic, pearlitic, or austenitic matrix. The corrosion-resisting characteristics of gray iron may be altered by alloying and by foundry techniques since both affect the size, shape and distribution of the graphite particles and influence the corrodibility of the matrix.

PENETRON I —

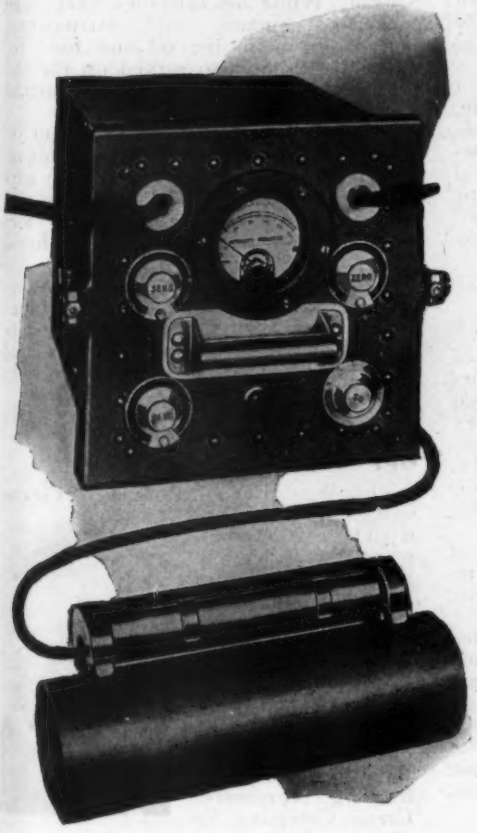
Measured thickness without drilling and calipering but weighed 400 lbs — required a trailer to carry it.

PENETRON II —

Achieved portability without loss of accuracy. Weight, only 40 lbs.



Research in Action!



PENETRON III —

Thanks to continuing research today's Penetron is *easily* portable yet even more sensitive. It weighs only 25 lbs.

How continuing Texaco Research developed a radically new idea and then made it better and better

THE PROBLEM: The drilling and calipering of oil industry equipment to check corrosion is costly, time consuming and often unsatisfactory. Texaco Research sought a better method that would quickly and accurately measure the thickness of a pipe or vessel *working from one side only.*

FIRST SOLUTION: After careful consideration exhaustive experiments with radium were undertaken. This resulted in the original Penetron, an efficient instrument but so heavy it had to be carried in a trailer.

SECOND SOLUTION: Further research reduced the weight from 400 to 40 lbs. The instrument was now portable and equally efficient but still heavy.

PRESENT SOLUTION: An instrument of even greater accuracy weighing only 25 lbs.

Thanks to Texaco Research today's Penetron is easily portable, easier to use. In addition to measuring wall thickness it is used to determine both the density and levels of contained liquids from outside the equipment.

TEXACO

TEXACO DEVELOPMENT CORPORATION

A Subsidiary of The Texas Company

ELECTRICAL INSULATING MATERIALS

EMPIRE

Varnished Materials.

MICANITE

Mica in various combinations with other materials, including Fiberglas.*

LAMICOID

In various grades, including those used for instrument panels, Bakelite-Fiberglas,* etc.

LABEL ENGRAVING MATERIALS

Black over white.
White over black.
Black over translucent.
Black over translucent over red.
SCARLET over white, etc.

We have the production facilities to fabricate insulators from laminated phenolic sheets, rods and tubes and carry a large stock of these materials in Houston.

GRAPHIC LAMICOID

Flow charts, electrical wiring diagrams, piping diagrams, etc., printed on the SECOND sheet of Laminated Phenolic, with a protective first transparent sheet.

* Fiberglas—Trade-name Owens-Corning Fiberglas Corp.

BAKORING
INCORPORATED
1020 HOUSTON, AVENUE
HOUSTON, TEXAS

About EQUIPMENT—SERVICE Suppliers

Merco Nordstrom Distributing Dow-Corning Valve Lubricant

Merco Nordstron Valve Company, 400 Lexington Avenue, Pittsburgh 8, is exclusive distributor of a new valve lubricant which posseses properties advantageous for a number of severe services. A Dow-Corning silicone product, it is identified as Norcoseal Lubricant No. DC234-S.

The lubricant is colorless and its viscosity changes only slightly over a wide temperature range. It is recommended for working temperatures from —40° to +400° F. It does not evaporate appreciably even at elevated temperatures.

Its principal services are steam, hot water, hot air, oxygen, high vacuum, also for dilute solutions of mineral acids (except nitric and hydrofluoric acid below 250° F.); hydrochloric acid, natural and synthetic rubbers, acetic acid, acetic anhydrids and ethyl alcohol below 250° F. It is available in bulk for application by grease gun.

Climax Industries Handling Sales of McAlear Equipment

Mid-Continent sales and service of engines, control equipment, separators and tanks will henceforth be handled by Climax Industries, Inc., factory owned distrbiutor of Climax Engineering Company, Clinton, Iowa, and McAlear Manufacturing of Tulsa and Chicago (formerly Hanlon-Waters and McAlear).

Allen George will have charge of drilling and oil-well engine sales, and will make headquarters at Fort Worth, Texas.

Jimmy Dvoracek has been appointed sales manager of the control division and will supervise sales of control equipment, separators and tanks. He will retain headquarters at Houston, and branch offices will be maintained at Corpus Christi, Wichita Falls, Odessa, Fort Worth, Texas; Houma, Louisiana; and Tulsa, Oklahoma.

Taylor Instrument Companies Announces Sales Promotions

Taylor Instrument Companies, Rochester, New York, has announced four changes in the personnel of its sales organization.

Raymond E. Olson has been made general sales manager to head sales activities, domestic and foreign. Olson came with the company in 1916 and after experience in the sales and sales engineering departments became manager of the latter in 1927. In October, 1944, he was elected to the board of directors. For several years he has served as director of the Dairy Industry Supply Association.

R. E. Olson

R. E. Clarridge

Succeeding Olson as sales engineering manager will be Ralph E. Clarridge, who came with the company in 1930 directly from Ohio State University where he received the degrees of Bachelor of Engineering Physics and Master of Science. While his activities have been concerned primarily with instrumentation problems in the oil and food industries, he has also served on the development commitee of the industrial engineering department.

Frank S. Ward, formerly assistant industrial sales manager, now becomes industrial sales manager. He has been with the company since 1917 and during this time has had a wide experience in sales work, both in the field and at the home office.

Assuming additional duties as commercial sales manager is W. Maben Griffith, whose department has charge of the sale of such items as household thermometers, barometers, compasses and medical instruments.

The Wm. Powell Company Appoints Branch Manager

The Wm. Powell Company, Cincinnati, Ohio has announced appointment of Allen B. Stiles as manager of the Philadelphia and Baltimore territory. Stiles, whose office is at 1520 Locust Street, Philadelphia 2, Pennsylvania, is well known throughout the eastern section of the country, having represented Crane Company for the past several years. In his new capacity, he will acquaint both the jobbing trade and industry generally with the complete line of Powell bronze, iron, steel, and corrosion-resistant valves.

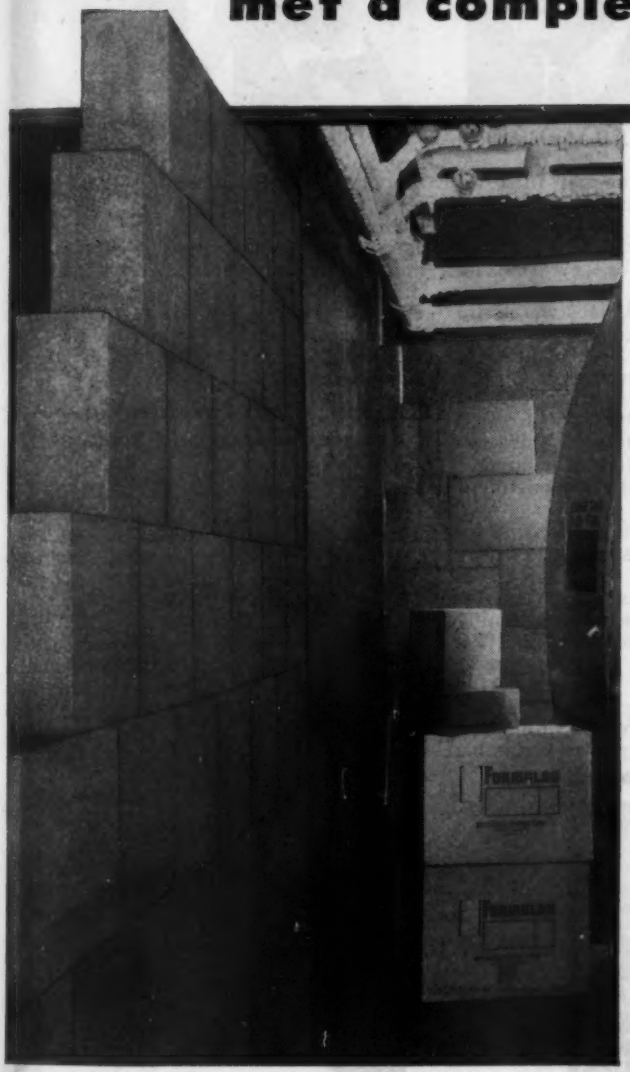
A. B. Stiles

Mathieson Alkali Announces Research Department Changes

Maurice C. Taylor, formerly manager of the Niagara Falls laboratories of The Mathieson Alkali Works, has been appointed resident director of research and development; J. Douglas MacMahon, assistant manager of the sales development department, has been named assistant to the technical director; C. N. Richardson, superintendent of pilot operations, has been named manager of research engineering, and C. Gerald Day, a superintendent in the development department has become research and plant liaison engineer. Dr. G. P. Vincent recently was named technical director.

Taylor joined the Mathieson organi-

How this extra strong insulation met a complex moisture problem



Foamglas being installed in the stock house of the Weber-Waukesha Brewing Co., Waukesha, Wisc.

Physical Properties of Foamglas*

Specific Gravity....0.17 (10 to 11 lbs./cu. ft.)
K (conductivity at 50° F.)..... 0.40 Btu/hr./sq. ft./°F./in.
Coefficient of Expansion (°F.).....0000046
Specific Heat...16 to .19 Btu/lb./°F.
Crushing Strength..150 lbs./sq. in.
Modulus of Rupture..90 lbs./sq. in.
Impact Strength (center drop-increment method on 8" x 16" x 5" thick specimens supported on a 12" span).....66 ft.-lbs.
Absorption (24-hr. immersion in water) 0.4% by volume—2% by weight (all at surfaces)
Air Infiltration or Permeability...0
Capillarity.....0
Volume Change with Moisture...0
(Data supplied by Pittsburgh Corning Corp.)

INSULATING a refrigerated high humidity room in a cold climate presents special difficulties in controlling moisture and frost. Armstrong's engineers solved this problem, in one instance, with an unusual construction.

Inside a brewery stock house in Wisconsin, temperatures were moderate but humidity was high, while outside winter temperatures often went well below zero. If moisture got into small crevices between the building wall and the insulation, and froze there, the insulation would be damaged. This particular outside wall was very rough and backplastering was impractical. If insulation were set directly against this wall, small air spaces would be left which might cause trouble.

Armstrong's Contract Service overcame these difficulties with Foamglas* insulation. This exceptionally strong and rigid material was erected as an independent wall, 3 stories high, set a minimum of one inch away from the building wall. The space between the two walls is provided with special drains so that moisture and frost cannot collect. Also since Foamglas is a positive vapor-barrier, moisture from indoors cannot get into this space through the insulation.

Foamglas insulation offers other advantages. It cannot sag, shrink, swell, or decay. And because it is made of tiny glass-walled sealed cells, Foamglas is also vermin-proof and fireproof. It provides lasting insulation efficiency.

For many refrigerated processes operating under unusually exacting conditions, these special qualities of Foamglas can be utilized. For full information, write today to Armstrong Cork Co., Building Materials Div., 7509 Concord St., Lancaster, Pa.

* Reg. U. S. Pat. Off. Product Mfg. by Pittsburgh Corning Corp.

ARMSTRONG'S INDUSTRIAL INSULATION

Complete Contract Service For All Temperatures

From 300° Below Zero

To 2600° Fahrenheit

PLIBRICO
Jointless FIREBRICK

The Answer to Your Refractory Problems!

FOR boilers and stills—for patching and repairs—for entire walls and complete relining—Plibrico Jointless Firebrick is the dollar-saving, trouble-saving refractory that refineries everywhere are adopting.

Plibrico forms a solid, monolithic lining that eliminates the weak joints of laid-up fire brick construction. Flexo-Anchors prevent bulging. No special shapes are required; Plibrico comes in moist, plastic form and can be readily moulded to any shape. Your own maintenance men can install it or we furnish complete installation service.

For extreme conditions, there is the Plibrico sectionally-supported air-cooled wall. And the Plibrico suspended arch for boiler arches and still roofs. Both are erected without special tile or heavy castings.

These catalogs cover your requirements.

Here is the complete story of Plibrico linings, arches, air cooling, etc. Ask for your Plibrico catalog. Specify whether operating H.R.T. or water tube boilers.

PLIBRICO JOINTLESS FIREBRICK CO.
1803 Kingsbury St., Chicago, Illinois

M. C. Taylor

J. D. MacMahon

C. N. Richardson

C. G. Day

zation as a research chemist in 1919, following graduation at Purdue University and service in Chemical Warfare. Successively chief research chemist and assistant director of research, he has been manager of research since 1941. His research work is covered by 26 patents. He is a member of American Chemical Society, American Electrochemical Society, American Institute of Chemists, and other organizations.

MacMahon is a graduate of Cornell University. He joined the organization in 1922 and has been assistant manager of the sales development department since 1941.

Richardson received his degree in electrochemistry from Massachusetts Institute of Technology in 1916, served in the war and four years with the Department of Agriculture before joining Mathieson as research engineer in 1924. He was put in charge of pilot operations in 1944. He is a member of the Electrochemical Society and American Institute of Electrochemical Engineers.

Day received his degree at Columbia University, and worked for du Pont before joining Mathieson in 1930 as a chemical engineer. He spent some time as superintendent of the development department of the company's plant at Saltville, Virginia, and then as chemical engineer at the Niagara plant. He is a member of the American Chemical Society and American Institute of Chemical Engineers.

Republic Steel Corporation Advances Clarke and Schlendorf

Republic Steel Corporation has announced election of N. J. Clarke as senior vice president, and J. M. Schlendorf as vice president in charge of sales.

Clarke has been vice president in charge of sales for the company since 1930. He started as office boy with Bourne-Fuller Company in 1897, became successively a salesman and manager for the company at Pittsburgh. In 1912 he became secretary and sales manager of Upson Nut Company which Bourne-Fuller Company had acquired. After service in War I as a major of

DIGESTER — jacketed, steel, with screw conveyors engineered to operate at 300 lbs per square inch working pressure.

Hicks century-old know-how goes into the engineering and fabrication of all types of process equipment.

SINCE 1841 Hicks
S. D. HICKS & SON CO.
Process Division: 51 E. 42nd St., New York 17, N.Y.
Plants: Hyde Park 36, Mass.

Write for our "Process Equipment Bulletin"

CLEAR-FLEXIBLE-INERT

Plastic
TYGON
Tubing

Laboratory Furniture
Scientific Apparatus
Industrial Chemicals
Commercial Acids
Geological Microscopes
Reagents

WESTERN TECHNICAL SUPPLY CO., INC.
306 West Second Wichita, Kansas

FILTER EXPERIENCE

. . . there is no substitute!

30 YEARS TO DATE

GOSLIN-BIRMINGHAM FILTERS are consistently selected by refiners as standard equipment for the M. E. K. solvent dewaxing process. Choosing an established and generally accepted product is a tribute to experience . . . into G-B FILTERS has been incorporated the experience of its staff of engineers who have designed, created, installed and operated Filters for many years.

●

EXPERIENCE vs. EXPERIMENTATION

GOSLIN-BIRMINGHAM DEWAXING FILTERS are time-proven, not just the 'attempts' at producing acceptable equipment. Refinery production schedules cannot be altered at will . . . schedules must be maintained and operating costs must be met. Experimentation with equipment of unproven merit is costly business, ruinous in many cases.

●

BUYER BEWARE

New-comers in the Filter manufacturing field have admittedly selected G-B FILTERS as their model for imitation. Investigation and study are the only means of determining the marked superiority of GOSLIN-BIRMINGHAM FILTERS over the products of embryo enterprise.

GOSLIN-BIRMINGHAM MANUFACTURING CO., INC.

BIRMINGHAM ALABAMA

350 MADISON AVE NEW YORK

CHICAGO SAN FRANCISCO NEW ORLEANS SEATTLE

B-H No. 1 insulating CEMENT

Your No. 1 choice for RUST RESISTANCE

B-H No. 1 Insulating Cement contains a special rust inhibitor which is fully effective even if the cement is allowed to dry out slowly on cold equipment. The metal surfaces which it covers will not be corroded. The bond between metal and cement will remain firm.

In *every* way B-H No. 1 Insulating Cement is ideal for maintenance work, especially for valves, fittings and irregular surfaces, large or small, and as a finish over blanket and block insulations.

Because its basis is nodulated *black* Rockwool, high in resistance to both heat and moisture, B-H No. 1 Cement provides maximum insulating efficiency up to 1800° F.—even under the most humid conditions.

It can be stocked without breakage or loss, is easily applied even by unskilled labor, and is fully reclaimable when used at temperatures not exceeding 1200° F.

THE COUPON BELOW will bring you full information and a practical sample of B-H No. 1 Cement.

Baldwin-Hill

SPECIALISTS IN THERMAL INSULATION PRODUCTS

Baldwin-Hill Co., 524 Klagg Ave., Trenton 2, N. J.

Send information on products checked below:

- ☐ Free sample of B-H No. 1 Cement
- ☐ No. 100 Pipe Covering—effective up to 1200° F. (for long runs overhead, underground, Diesel exhausts)
- ☐ Mono-Block—the one-block insulation for all temperatures up to 1700° F.
- ☐ Black Rockwool Blankets (felted between various types of metal fabrics)

NAME _____ POSITION _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

ordnance, he returned to Bourne-Fuller Company as vice president and general manager. In 1919 he organized and became president of Lake Erie Bolt & Nut Company.

Schlendorf was with American Sheet & Tin Plate Company from 1905 to 1915. During the next two years he was assistant purchasing agent of Willys-Overland Company, and in 1917 became vice president in charge of sales for Central Steel Company, continuing in that position when the company merged with United Alloy Steel Corporation in 1926 to form Central Alloy Steel Corporation. When the latter became part of Republic Steel Corporation in 1930 he was appointed manager of sales of the alloy division, and in 1936 was made assistant vice president in charge of sales.

R. E. Nagel to Represent Fluor Corporation in New York

R. E. Nagel has been appointed district sales manager for The Fluor Corporation of Los Angeles, and will have headquarters at the company's offices in New York.

R. E. Nagel

Nagel was with Universal Oil Products Company for 24 years during which he served in various capacities, first as a draftsman, then as supervising construction engineer, superintendent of construction and operator on experimental and commercial thermal cracking units, and in the research and development department.

Sykora Director of Sales for Portable Products Corporation

John C. Sykora has been elected vice president and director of sales for all divisions of Portable Products Corporation, Pittsburgh. He will direct activities from newly established headquarters in the Woolworth Building, New York. Sykora formerly was vice president and sales manager for Gould Storage Battery Corporation.

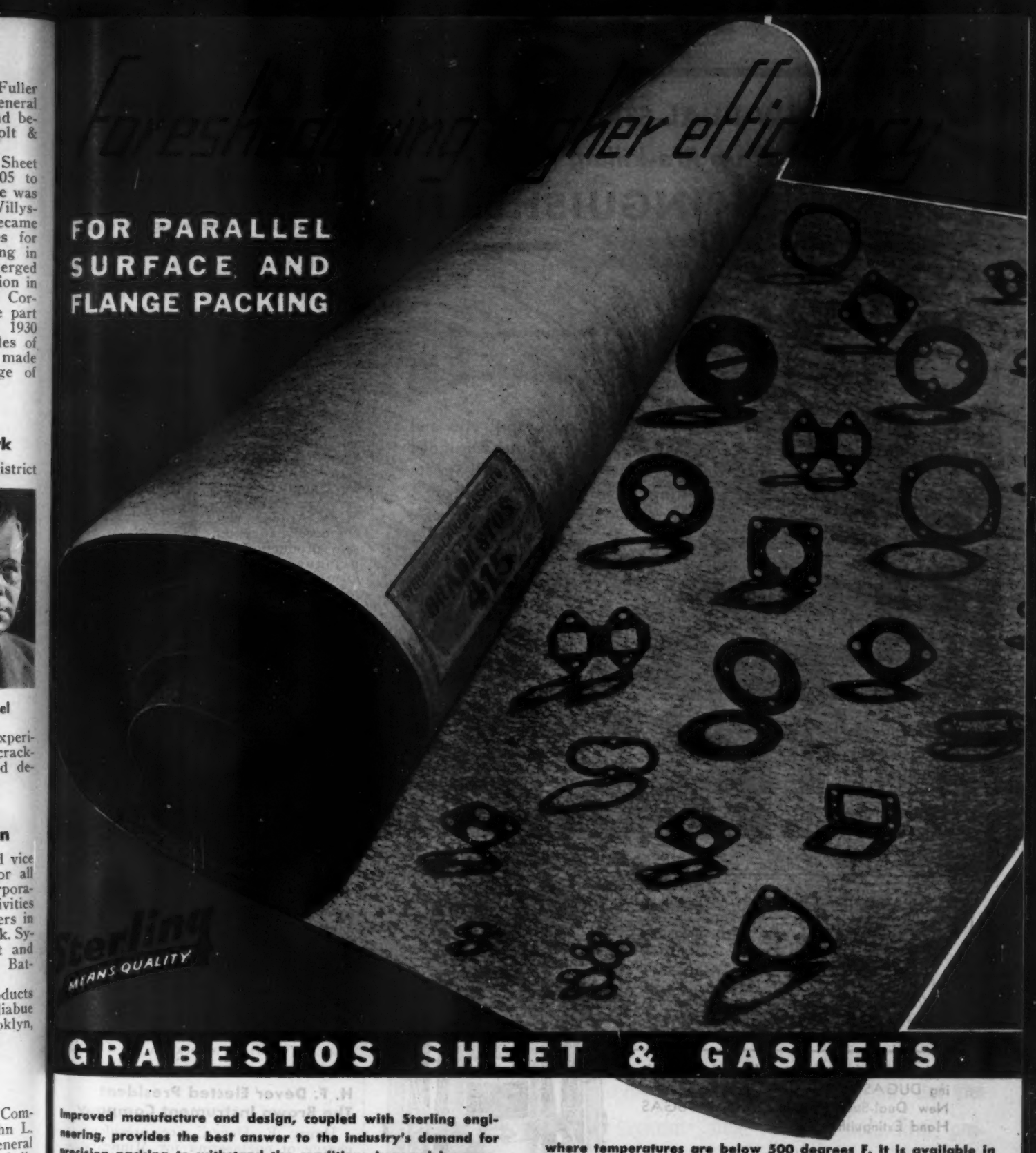
Included in the Portable Products Corporation group is C. J. Tagliabue Manufacturing Corporation, Brooklyn, recently acquired.

Laclede-Christy Sales Executives Promoted

Laclede-Christy Clay Products Company, St. Louis, has promoted John L. Cummings, vice president and general sales manager, to vice president and director of sales, and has elected Julius A. Kayser a vice president to be general sales manager

Kayser, an engineering graduate of The Royal Technical Institute, Copenhagen, has been with the company 22 years, serving in both sales and manufacturing capacities. His most recent duties included chief refractories engineer and assistant vice president.

Harvey R. Miller, district manager at Chicago, has been made an assistant vice president and assigned to direction of sales in an enlarged area adjacent to Chicago. He is an engineering graduate of Carnegie Institute of Technology



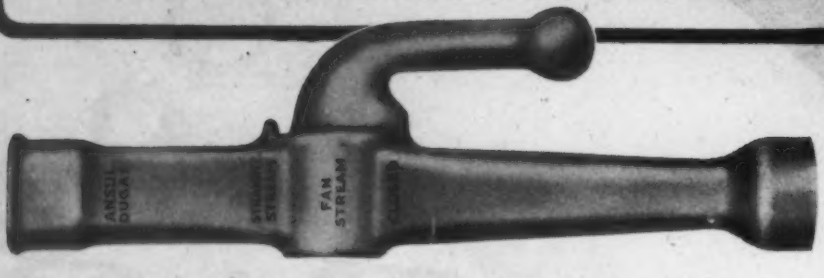
GRABESTOS SHEET & GASKETS

Improved manufacture and design, coupled with Sterling engineering, provides the best answer to the industry's demand for precision packing to withstand the conditions imposed by present-day high speed, high temperature and high pressure. All Sterling sheet packing and gaskets are precision engineerd to give most efficient service in their recommended installations. This Grabestos Compressed Sheet, Style No. 415, is a homogeneous sheet composed of long fibre asbestos, possessing high tensile strength due to the selected fibre binder used. It is applicable for steam, gas, oil, water, mild acid and alkali installations where temperatures are below 500 degrees F. It is available in thicknesses of 1/64", 1/32", 1/16", 1/8" and 3/16".

Grabestos, as well as all other Sterling Sheet Packing is available in sheets and rolls of convenient widths and lengths for stock or all size standard ring, full face and intricate pattern gaskets.

Sterling engineers can recommend, and supply, the proper sheet and gasket for all parallel surface and flange packing conditions.

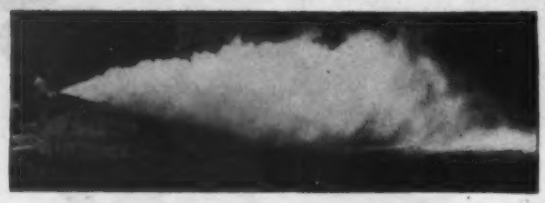
NOW...NEW DUAL-STREAM NOZZLE
further steps up fire-killing punch of
DUGAS EXTINGUISHERS!



NEW DUAL-STREAM NOZZLE deals effectively with spill fires and fires difficult to reach because of height or obstructions. Designed for use with DUGAS wheeled extinguishers, the new Dual-Stream Nozzle greatly increases fire fighting range and effectiveness. A turn of the handle gives a *straight* stream with a range of 45 feet—or a *fan* stream with a range of 15 feet.

STRAIGHT STREAM of fire-killing DUGAS Dry Chemical permits a large fire to be knocked down from a safe distance before operator goes in to extinguish it.

FAN STREAM enables operator to concentrate heavy cloud of DUGAS Dry Chemical on fire and minimizes flash-backs.



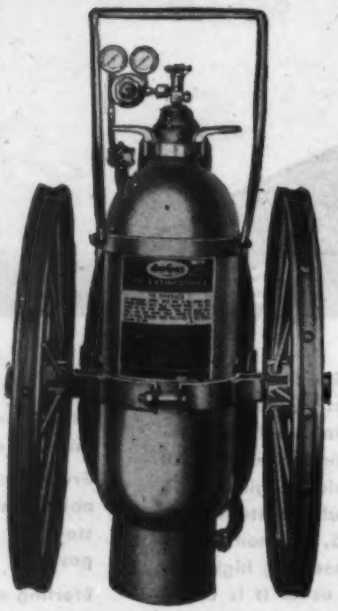
***Quick Facts about* DUGAS Dry Chemical**

- For extra-hazardous fires involving flammable gases, liquids, greases or electrical equipment.
- Not an electrical conductor.
- Non-toxic, non-corrosive, non-abrasive.
- Not affected by extreme cold or heat.

Write today for complete information regarding DUGAS Wheeled Extinguishers with the New Dual-Stream Nozzle... and DUGAS Hand Extinguishers.

AN ANSUL PRODUCT
duGas
THE MASTER OF FLAME

Approved by Underwriters' Laboratories, Factory Mutual Laboratories.



DUGAS 150-A WHEELED EXTINGUISHER

ANSUL CHEMICAL COMPANY, MARINETTE, WISCONSIN
DUGAS DIVISION

and has been with the company 22 years.

John W. Rogers was appointed an assistant vice president, and will continue as sales manager of the glass refractories division. He is a graduate of Massachusetts Institute of Technology and has been with the company 20 years.

McReynolds, Heinzerling, Arduser Vinson Supply Company Partners

B. W. Vinson, president of Vinson Supply Company, Tulsa, has announced that J. M. McReynolds, J. H. Heinzerling and H. W. Arduser have been admitted as general partners of the company.

McReynolds, sales manager, has been associated with the company for over nine years and is in charge of all supply lines and active in the company's management. Heinzerling, assistant sales manager, has been associated with the Vinson Supply Company for over four years. H. W. Arduser, chief engineer, had extensive production experience with oil companies before joining the company eight years ago.

J. M. McReynolds

J. H. Heinzerling

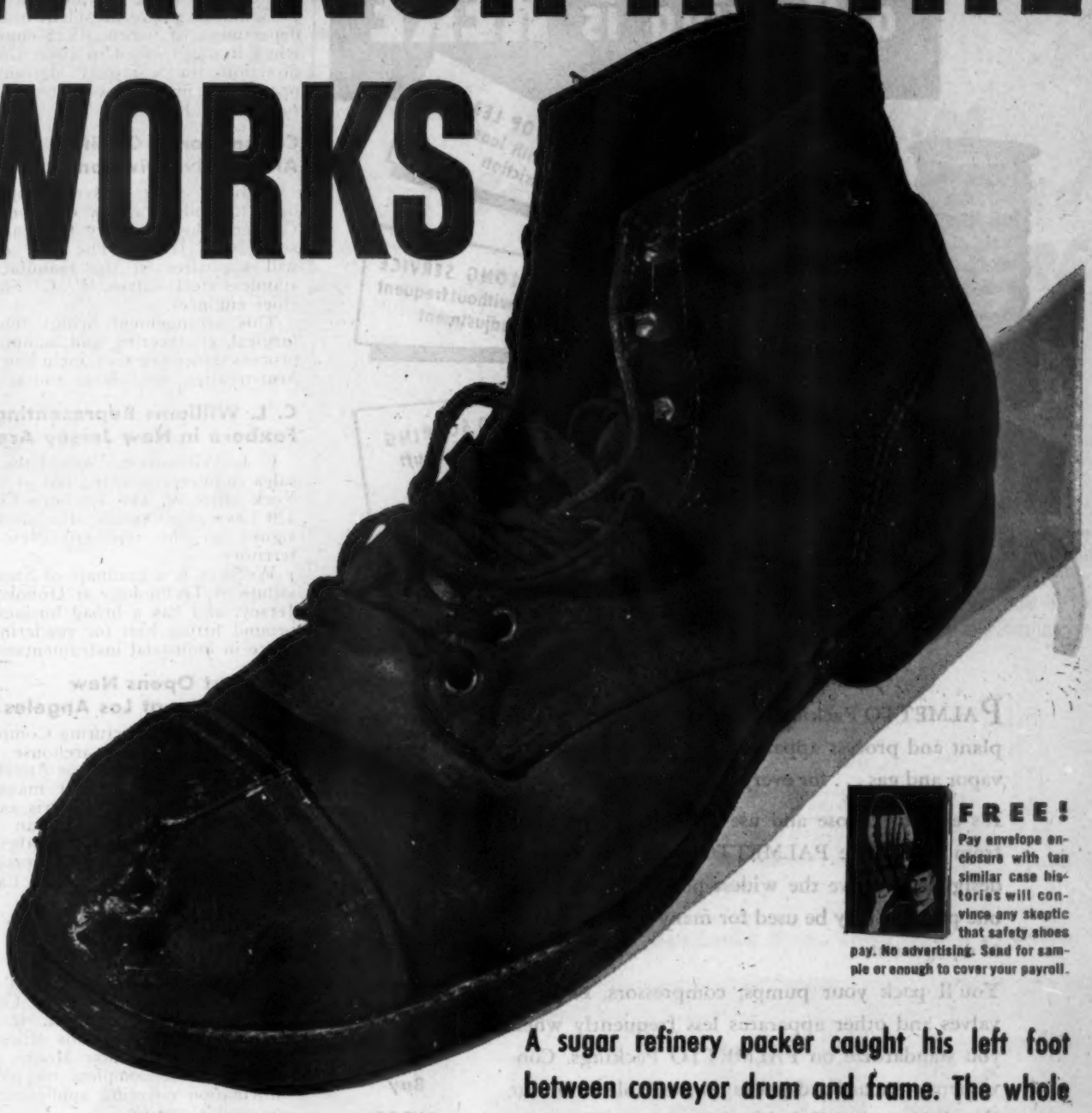
H. W. Arduser

Vinson Supply Company has long been associated with the refining and natural gasoline industry throughout the Mid-Continent, supplying many nationally known lines of equipment. Headquarters are at 220 North Boston, Tulsa, where general offices are located and extensive stocks are maintained. A branch office under the management of G. B. Lane is located at Dallas. The company also maintains a branch at Odessa, Texas.

H. F. Dever Elected President The Brown Instrument Company

Henry F. Dever, vice president in charge of engineering for Minneapolis-Honeywell Regulator Company, has been elected president of The Brown Instrument Company, where he succeeds Charles B. Sweatt, a vice president of the regulator company, who will devote all his attention to sales matters for Minneapolis-Honeywell Regulator Company and its subsidiaries, of which The Brown Instrument Company is one. Dever also assumes the responsibilities of E. B. Evleth, who has requested relief as general manager of The Brown Instrument Company because of ill health. W. J. McGoldrick, who has been vice president in charge of aeronautical engineering, succeeds

WRENCH IN THE WORKS



FREE!

Pay envelope enclosure with ten similar case histories will convince any skeptic that safety shoes pay. No advertising. Send for sample or enough to cover your payroll.

A sugar refinery packer caught his left foot between conveyor drum and frame. The whole line stopped, chewed up the leather. But the Lehigh Lockrim* steel toe box held firm, prevented a badly crushed foot. There was no injury. And production was under way again in a matter of seconds. Like so many accidents, this one never should have happened. Someone was careless. But this time Lehighs were on the job. How's the foot injury rate in your plant?

*T M REG

LEHIGH ALLENTOWN, PA.

SAFETY SHOE CO., INC.

WESTERN OFFICE: 12TH AND SPRUCE, ST. LOUIS 2, MO.

What YOU want in a Packing is HERE

STOP LEAKS with least friction
LONG SERVICE without frequent adjustment
NO SCORING of rod, shaft or stem
EASY SELECTION of correct packing for each purpose
PALMETTO
SELF-LUBRICATING PACKING

PALMETTO Packings are made for every power plant and process apparatus . . . for every liquid, vapor and gas . . . for every service condition.

It's easy to choose and use the RIGHT packing from the simple PALMETTO line. Each type is designed to serve the widest possible range, and one package may be used for many different types of equipment.

You'll pack your pumps, compressors, engines, valves and other apparatus less frequently when you standardize on PALMETTO Packings. Convenient standardized packages available from our Distributors in all industrial centers. Write for descriptive literature.

For Final Victory, Buy MORE Bonds

GREENE, TWEED & COMPANY

Bronx Blvd. at 238th St., New York 66, N. Y.
Plants at New York, N. Y. and North Wales, Pa.

PALMETTO

PALMETTO for steam, water, air • PELRO for oils • CUTNO for alkalis • SUPER-CUTNO (blue asbestos) for acids. • KLERO for foods

Self-Lubricating **PACKINGS**

Dever as director of engineering for the parent organization.

Dever, an electrical engineering graduate from Northwestern University, joined the company's sales organization in 1931, and has been director of engineering since 1939. McGoldrick became a member of the engineering staff in 1935, and as a vice president headed the department of aeronautical engineering when it was formed in 1941. Under his direction the company designed and produced a number of electronic devices for the Air Forces.

Cooper Forms Certified Alloy Valve Division

Certified Alloy Valve Company has been formed as a new division of The Cooper Alloy Foundry Company, Hillside, New Jersey. The new company will specialize in the manufacture of stainless-steel valves. P. C. Shaffer is chief engineer.

This arrangement brings the metallurgical, engineering and manufacturing process under one roof, including casting, heat-treating, machining and testing.

C. L. Williams Representing Foxboro in New Jersey Area

C. L. Williams has joined the staff of sales engineers working out of the New York office of The Foxboro Company, 420 Lexington Avenue. He has been assigned to the northern New Jersey territory.

Williams is a graduate of Stevens Institute of Technology at Hoboken, New Jersey, and has a broad business background fitting him for rendering assistance in industrial instrumentation.

Kerotest Opens New Warehouse at Los Angeles

Kerotest Manufacturing Company has established a new warehouse at 3311 East Slauson Avenue, Los Angeles, with J. A. Swaton as district manager for steel valves and J. A. Norris as district manager, brass division. Van D. Clothier will continue as Southern California representative for brass valves with headquarters at 1015 East 16th Street, Los Angeles.

McGowan Pump Division Opens New York Office

McGowan Pump Division of Leyman Manufacturing Company, Cincinnati, Ohio, has opened offices at 342 Madison Avenue, New York. This office will be managed by J. Arthur Moore, and will have available complete technical sales information covering application of the company's pumps.

Modern Processes Seen as Adding Emphasis to Operating Procedures

Operating procedures in oil refining have greatly increased their importance as result of the modern basic advances made in processing, it is pointed out in The Kelloggram, No. 4, 1945, published by The M. W. Kellogg Company. Citing as an example the procedure involved in starting up and operating a fluid catalytic cracking unit, this issue of the magazine emphasizes that thorough knowledge of all phases of design and operation of each installation is essential to assure full efficiency of a unit.

The article then describes a procedure of operating instructions which was developed some years ago by the company and which it is stated has been

HERE'S A PLUG VALVE

THAT STAYS "ON STEM"

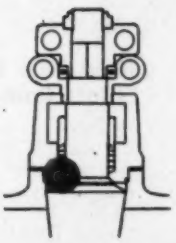
Worn Stem Packing Safely, Quickly Replaced UNDER PRESSURE

HAMER
GLAND - PACKED PLUG VALVE

There are many places in refineries, process plants and on ship board for this successful Hamer Plug Valve. Look at the sketches—see how easily and safely the stem packing can be changed *without* shutting down the line. Then send for the Hamer Catalog which gives engineering data on this and other Hamer products.

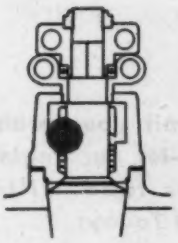
RAISE PLUG TO SEAL BONNET

Turning plug adjusting nut to LEFT raises plug, brings lapped shoulder of plug and bonnet into tight sealing contact.



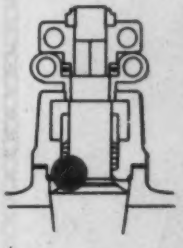
RAISE GLAND TO REPLACE PACKING

Only two nuts to remove. Plenty of working room for quick packing replacement.

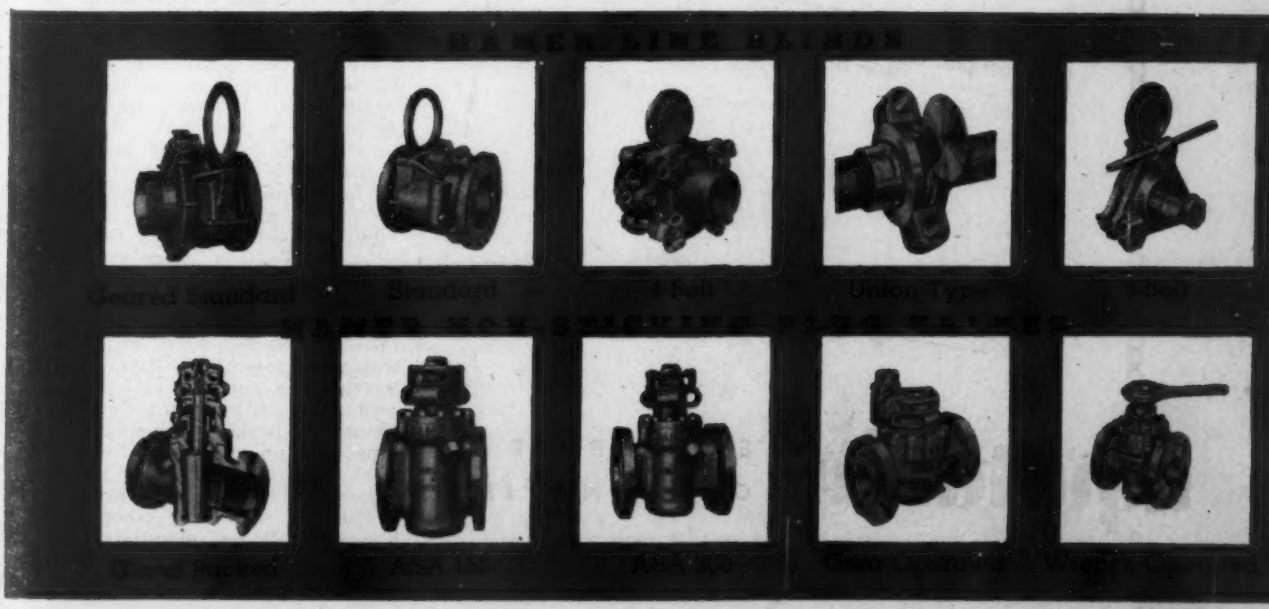


LOWER PLUG BY TURNING NUT TO RIGHT

This returns plug to proper adjustment in body, and nut maintains the adjustment for positive turning of plug under all conditions.



HAMER OIL TOOL CO. 2919 Gardenia Ave., Long Beach 7, Calif.



Our complete line of hoists enables us to deliver the unit you want whether your requirements are for the smallest hand hoist or the largest engine driven unit. Equitable can supply you with hoists for every purpose — hand, electric, air or engine driven.

Submit your problems to us—let our engineers lift your load. Fill in and Mail Today:

EQUITABLE EQUIPMENT CO., INC.
410 Camp St., New Orleans, La.

Name _____
Address _____ State _____
City _____ Lift _____ Ft.
Capacity _____ Phase _____ Cycles
Elect. _____ Volts _____

Equitable EQUIPMENT COMPANY, INC.

410 CAMP STREET • NEW ORLEANS, LA.

found by customers to prove highly satisfactory in meeting this need.

As the unit is designed, piece by piece, Kellogg's operating engineers document for themselves a pattern of operation. When finally completed, tested and approved, this pattern of operation becomes a permanently available operating manual covering all engineering knowledge about the unit from processing principles through each aspect and contingency of operation down to the details of maintenance and care. This volume, it is pointed out, constitutes a permanent continuation within book covers of the guidance given verbally to refinery operating crews by Kellogg field engineers at the starting-up of each unit.

Another article in the same issue describes how a new hydroformer precision control system has aided The Pure Oil Company in achieving a notable record in production of aviation gasoline. Developed by Kellogg engineers working in collaboration with engineers of General Electric Company, this control equipment times every operation—starting, stopping, or accelerating or reducing rates of speed—down to a few seconds. By making operation almost 100 percent automatic, it virtually eliminates the human equation.

Arnold H. Smith Named Monsanto Foreign Director

Arnold H. Smith has been appointed director of the foreign department of Monsanto Chemical Company, succeeding Herbert M. Hodges who is retiring. Smith will be succeeded as assistant director of the foreign department by Marshall E. Young, formerly general export manager. Smith was manager of the company's petroleum chemical sales at St. Louis from 1940 to 1944, when he was made assistant director of the foreign department.

New Test Laboratory for Elliott Company

Construction of a new test laboratory to cost $750,000 and greatly extending the facilities of the research engineering division of Elliott Company, Jeannette, Pennsylvania, is announced by Grant B. Shipley, president.

Plans for extensive research and development on gas-turbine power plants have called for a new main building, 60 x 140 feet, and several small buildings. Construction is expected to be completed within six months.

Among the permanent installations will be test stands for gas turbines, compressors and blowers, heat-transfer equipment, a combustion laboratory, a metallurgical laboratory, and an experimental machine shop.

The gas-turbine test stand will be used for testing many sizes of gas turbines. The power source for the test stand will be a combustion chamber capable of providing 12,500 feet per minute of compressed air at any pressure up to 35-pound gauge and any temperature up to 1500° F. The test stand will be equipped with a permanent foundation for mounting turbines, and a special, electronically controlled, eddy current, dynamic power absorption brake which will be good for capacities up to 5000 horsepower and 5000 rpm, and capable of measuring the output power with great accuracy.

The test stand for compressors and blowers will be operated by a 2500-horsepower steam turbine for driving in either direction, with a permanently

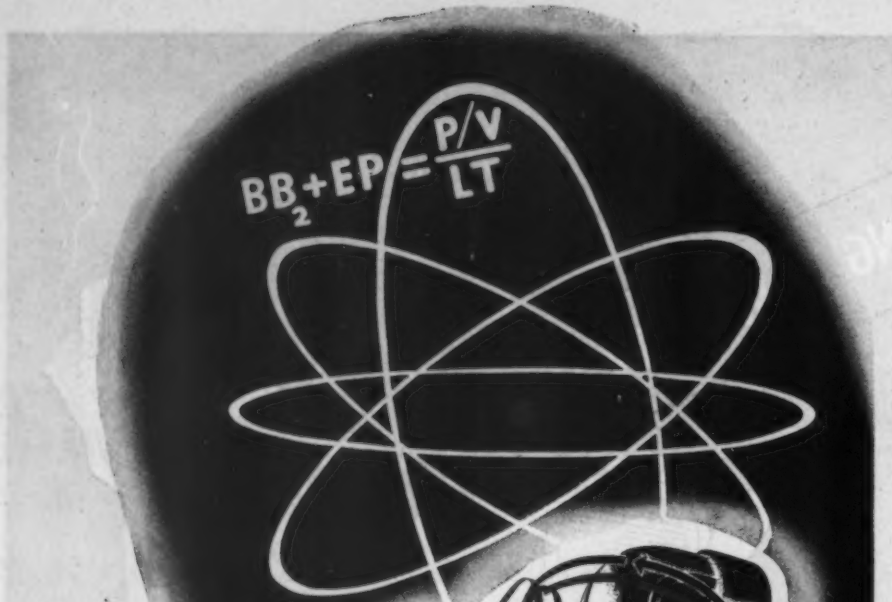
Here's an insulation that won't "fall down" on the job! Unibestos will not sag, gap, shatter or shakedown under the most severe vibration—always remains snug and firm against pipe, thus assuring maximum protection with a minimum of heat loss. Moreover, Unibestos efficiency is unaffected by moisture. Even when soaked, moisture can be steamed off without damaging Unibestos structural strength.

Unibestos is available in half-section form up to 30" pipe diameter, and in quarter-section form from 32" to 60"—in thicknesses from ¾" to 5". Single layer construction is available for service up to 1200°.

UNION ASBESTOS
MEANS PROGRESS IN INSULATION
AND RUBBER CO.

PLANTS: 1821 S. 54th Ave., CICERO, ILL. • PATERSON, N. J. • BLUE ISLAND, ILL.
OFFICES: CHICAGO • CICERO, ILL. • NEW YORK • SAN FRANCISCO • PATERSON, N. J.

COPYRIGHT 1944
UNION ASBESTOS AND RUBBER CO.



BB_2=Double rows of Ball Bearings
EP =Effective Packing Element
P/V=Pressure or Vacuum
LT =Low Torque under all conditions.

Perfect flexibility with low torque is assured in every CHIKSAN *Ball-Bearing* Swivel. Yet Chiksan design and construction are so sound they can be expressed in a simple formula. There is nothing to tighten or adjust... no stuffing boxes to put the brakes on easy turning and thus produce excessive strains on pipe lines and fittings. Smooth, easy turning throughout 360° is provided in one, two and three planes. Packing Element is so effective the same Swivel may be used for either pressure or vacuum service... for loading or unloading. Chiksan *Ball-Bearing* Swivels are built for pressures to 3,000 p.s.i. and varying temperatures. Write for latest catalog.

Chiksan Representatives in Principal Cities

CHIKSAN
TRADE MARK REG.
BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES
CHIKSAN COMPANY
BREA, CALIFORNIA

mounted complete surface condenser and all auxiliaries, arranged so that horsepower input into the steam turbine can be accurately measured. An extremely accurate strain gauge type torque meter which can be installed on the shaft between the turbine and the compressor being tested will be part of the equipment. This stand will also include a series of orifices to measure air flows up to 30,000 cubic feet per minute.

A stand for the testing of heat-transfer equipment designed for air-to-air high-temperature studies on extended surface type units will obtain its hot air from the same combustion chamber used to supply the gas-turbine test stand. Cold air up to 10,000 cubic feet per minute will be supplied by a separate blower.

A completely equipped combustion laboratory to be used for the design development and testing of gas combustion chambers using heavy oils and powdered coal will also take its air supply from the turbine test stand. In addition to equipment for coal weighing and pulverizing, the laboratory will be complete with all necessary measuring devices for temperature, pressure and flow quantities. For development work with gasoline for small turbines, a separate building will be erected apart from the main building.

A wind tunnel for aero-dynamic testing of turbine blades as well as compressor blades and other air flow sections will have a capacity of 10,000 cubic feet per minute and will be capable of producing velocities approaching the speed of sound.

A metallurgical laboratory for testing high-temperature metals will have in addition to standard equipment normal temperature fatigue testing machines, photo-microscopic equipment, a 120,000-pound tensile testing machine, Rockwell and Brinnell hardness testing equipment, laboratory-size heat-treating and temperature equipment, and salt spray equipment for corrosion tests.

An experimental machine shop with a large assortment of up-to-date machine tools will serve for both engineering research, and the improvement of machinery and manufacturing methods.

Westinghouse Acquires B. F. Sturtevant Company

Westinghouse Electric Corporation has acquired B. F. Sturtevant Company of Boston, and will operate it as a subsidiary in expansion of its air-conditioning activities. The Sturtevant company is a pioneer in the fan and blower field, heating, cooling and air-conditioning apparatus. Headquarters of the expanded Westinghouse air-conditioning activities will be at Boston, but heavy-duty and industrial refrigeration manufacture will continue at Jersey City, along with production of the Westinghouse electronic air cleaner.

The Sturtevant company has other factories at Camden, New Jersey, La-Salle, Illinois, Berkley, California, and Galt, Ontario, Canada.

Cooper-Bessemer Gas-Diesel High in Thermal Efficiency

Thermal efficiency in excess of 40 percent has been announced by The Cooper-Bessemer Corporation, Mount Vernon, Ohio, as having been attained during routine tests on one of the company's regular Type JS engines. The engine involved is the gas-diesel announced by the company early this year.

NEW EQUIPMENT

...MANUFACTURERS' · LITERATURE...

FOR FREE COPIES OF MANUFACTURERS' LITERATURE OR MORE INFORMATION ON PRODUCTS DESCRIBED ON THESE PAGES, USE THE MAILING CARD INSERTED IN THIS ISSUE

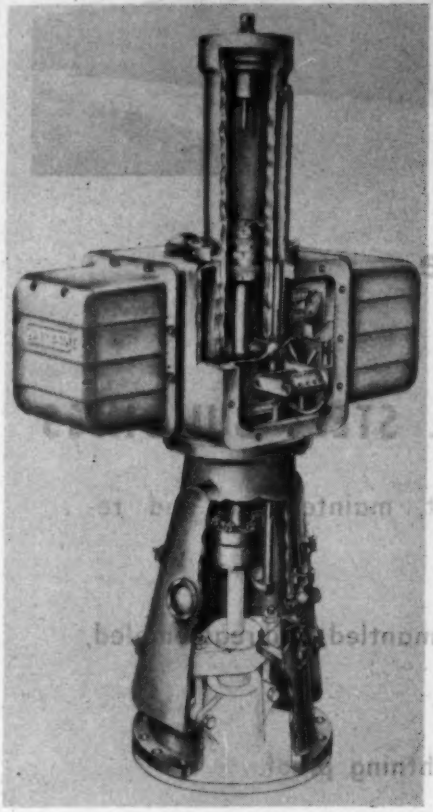
1—Hydraulic Valve Actuator

Pacific Division, Bendix Aviation Corporation, North Hollywood 44, California, has announced the Bendix Actuator, a hydraulically operated valve actuator which is being marketed under the name of Bendix Hydrodyne Actuator.

The unit incorporates a simple hydraulic system which produces force in a straight line through a hydraulic cylinder to open and close the valve. As the valve seats the hydraulic pressure continues to build up, literally pressure-sealing the gate against leakage. Pressure then is hydraulically locked in the cylinder and only the reverse action will unlock it. Should pressure drop from any cause it is automatically reestablished immediately. In addition, the unit is provided with a completely independent hydraulic system, using a hand pump, for emergency.

The pressure-sealing action eliminates "bounce" or backlash in the seating operation. Further advantages of the hydraplic operation eliminates "hammer-blow" action, and reduces maintenance to routine inspection as the hydraulic oil serves as a lubricant for all moving parts.

Units are available for use on valves from 4 to 36 inches, and auxiliary regulating and indicating equipment can be provided for step-by-step position control, infinite position control or on-and-off control for virtually any type of application.



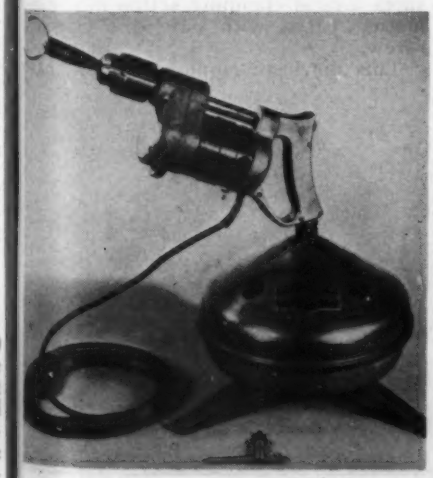
Bendix Hydrodyne Actuator

2—Tube-Cleaning Tool

Spartan Tool Company, 6007 Lincoln Avenue, Chicago 45, announces a self-contained power-driven tool for cutting and removing obstructions, stoppages, slush or scale from curved or fitted pipes, drains, tubing, sewer lines, steam risers, humidifiers, etc.

The machine is designed to house and drive 100 feet of ½-inch flexible steel shafting. The flexible rod automatically coils and uncoils as it is fed into and from the container. The driving mechanism is a motor-driven head which is removable from the stand. In operation, this driving unit is held at the opening of the pipe or tube so that the desired length of flexible rod may be fed into the pipe.

For removing waste material or scale, the flexible rod is equipped with elyptical shaped, spring steel, cutter heads. The flexible shafting rotates the cutter head through the line regardless of the number of 90° elbows or T's therein. Upon encountering resistance from obstruction within the cylindrical opening, the effect of the flexible rod is to store up energy until the accumulated torque overcomes the resistance.



Spartan Tube-Cleaning Tool

3—Plastic Joint-Flange

Commercial Plastics Company, 201 North Wells Street, Chicago, has announced a plastic joint-flange, said to be strong, durable and both acid and alkali resistant. The joint-flange consists of a flanged endpiece which is heat-welded onto the plastic pipe, and a steel ring for bolting onto a similar joint-flange to which the end is to be connected. It is available in several sizes up to 4 inches

4—Bimetal-Element Dial Thermometer

Equipoise Controls, 242 Madison Avenue, New York 17, has announced a new bimetallic dial thermometer featuring a permanently-calibrated helical coil measuring element in an alloy-steel case, stainless-steel nut and stem, and easily read graduations.

Expansion of the bimetallic coil rotates an attached small shaft and indicating pointer as one unit over the scale range as the only moving part.

Standard ranges are available between 90° F. and 1000° F. Test or laboratory thermometers are graduated in both Centrigrade and Fahrenheit on the same scale. Dial sizes 2-, 3- and 6-inch are available. Installed by connecting ½-inch standard connection nut directly into point of service or into separable socket or other mounting accessory.

5—Corrosion-Proof Cement

Pennsylvania Salt Manufacturing Company, 1000 Widener Building, Philadelphia 7, has announced a new resin-type cement for bonding corrosion-proof brick and tile where both acids and alkalis are encountered.

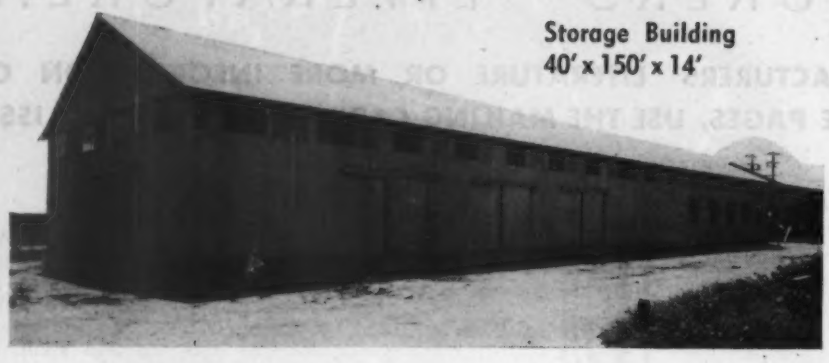
Known as "Pennsalt PRF Cement," the product is composed in a liquid and a powder which, when mixed, react chemically to form a cement. An available bulletin gives details, including a list of chemicals which the product resists.

6—Foam Engine

American-LaFrance-Foamite Corporation, Elmira, New York, recently has announced a new 40-gallon Foamite Model FMC foam engine which is said to produce more than 450 gallons of foam. A metering feature permits mixing of

Foamite Model FMC

BRADEN
SECTIONAL STEEL BUILDINGS



Storage Building
40' x 150' x 14'

These features are common to all—

BRADEN SECTIONAL STEEL BUILDINGS

ECONOMY in first cost, maintenance and re-assembly.

PORTABILITY—Easily dismantled, and reassembled, enlarged or changed.

FIRE RESISTANT and lightning proof.

RUGGED—MAXIMUM strength with a minimum of weight in proven materials minimizes deterioration.

Let Braden engineers design your individual building from factory fabricated standard panels.

BRADEN *Steel* BUILDINGS

BRADEN STEEL CORPORATION

1007 East Admiral Blvd., P. O. Box 1229, Tulsa 1, Oklahoma

Subsidiary of MOORLANE COMPANY

Branch Offices: Houston and Dallas, Texas, and Cleveland, Miss.

Representatives: Kansas City, Mo., Amarillo, Tex., Wichita, Kansas., Odessa, Tex., Oklahoma City, Okla.

Export Agent: Russell D. Heath, Room 605, 125 Barclay St., New York 7, N. Y.

For copies of manufacturers' literature or additional information on products described, use mailing card, at page 273.

solutions in measured quantities throughout the discharge period rather than dumping the volume together at the start. The unit is wheel mounted and equipped with 50 feet of 1¼-inch hose. Range of stream is 50 to 60 feet and period of discharge 2½ minutes.

7—Gate Valves

Shand & Jurs Company, Berkeley, California, has announced a quick-acting gate valve with special stem and nut design, in which the disc rises with the stem as the stem rises in the nut, thus accomplishing full opening and closing in a minimum number of turns.

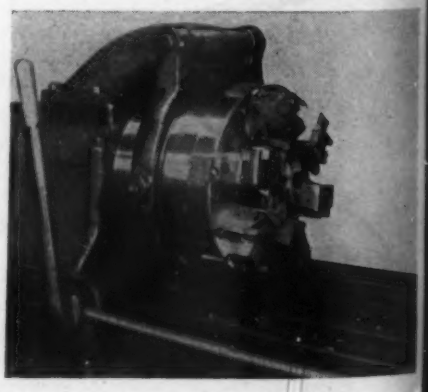
S & J TT-135

Designed for exposure to butadiene, styrene and various sour stocks, and catalogued as No. TT-135, the four-inch size is available in steel body only, with either brass or 18-8 stainless-steel trim. The stainless-steel trim includes the stem, stem nut, discs, bonnet nut and all moving or threaded parts. The valve seats furnished with this trim are inserted steel rings faced with a deposit of Hastelloy B, an extremely hard and corrosion-resistant alloy made by Haynes Stellite Company. The six-inch valve is available with either steel or iron body.

8—Die Head

Landis Machine Company, Waynesboro, Pennsylvania, will have as a post-war product the "Lanco" 4-inch semi-receding 6-chaser die head, which will have a capacity from 2½ to 4-inch pipe size, this range being covered by chaser holders mounted on slides of heavy cross-section to assure maximum rigidity. The chaser holder slides are gibbed to the head body to provide compensation for wear. The interlocking design of the holder and slide assures a rigid clamping action of the two mating parts, with only one clamping screw.

This die head employs a new chaser



Landis 6-Chaser Die head

Stepless VARIABLE SPEED operation

offers tremendous advantages on many applications. And when you can vary the speed electrically, either automatically or by remote control push button, you not only add advantages . . . you multiply them.

For example, look at the power unit below. Designed for full automatic operation, it can be adjusted to operate on any predetermined duty cycle so that changes in speed can be made either rapidly or slowly, as required.

In many processes, such a power unit is very desirable for changing the speed automatically to compensate for changes in temperature, pressure, humidity, consistency, or size of material, or to synchronize with other operations.

Once adjusted, the operation requires little attention, so that one operator can easily take care of several machines. Result . . . a better quality product and lower labor costs.

Yours may not be a job where full automatic operation is required, but controlled variations in speed by remote push button may add greatly to its efficiency and convenience.

Next time you need a drive for mixers, grinders or pulverizers, heat treat or baking ovens, automatic plating equipment, reeling devices, proportioning equipment . . . to name only a few . . . see what a really remarkable job Master Speedrangers with electric remote control can do for you.

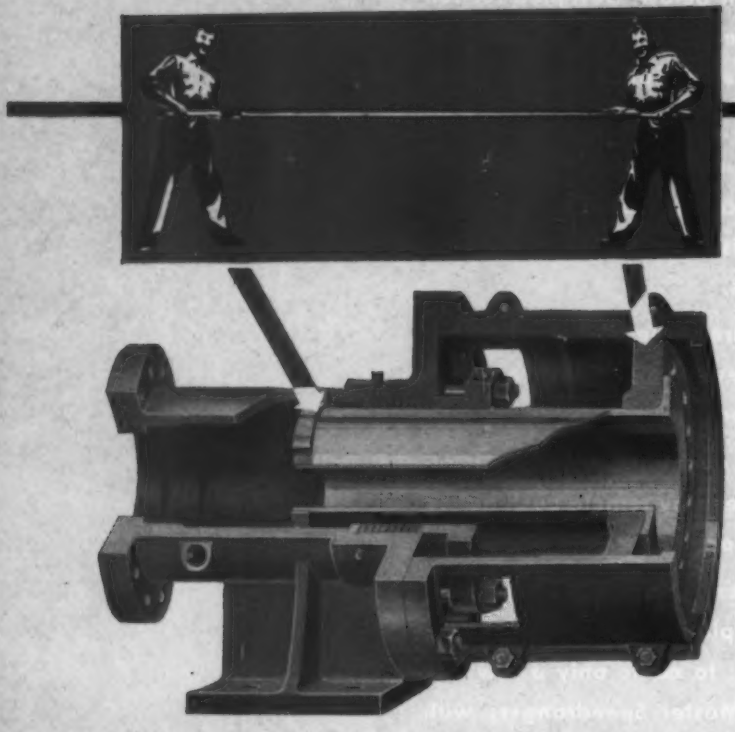
THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

MASTER SPEEDRANGERS

ADSCO

INTERNALLY-EXTERNALLY GUIDED EXPANSION JOINTS

Keep the slip in perfect alignment because they are guided at BOTH ends



Slip Moves Through Packing Without Binding

Try to hold a pole at one end and keep it level. Then have someone hold the other end, and note the difference. That's precisely why the ADSCO Internally-Externally Guided Expansion Joint stays in alignment—why the slip moves through the packing space without undue pressure or distortion.

This protection against slip scoring is the reason why the intervals between repacking are few and far between when you use ADSCO Internally-Externally Guided Expansion Joints.

Install them on high or low pressure pipe lines, hot water, fuel oil, gasoline or process—wherever the most complete form of guiding is required. Write for Bulletin No. 35-20RE describing ADSCO Internally-Externally Guided Expansion Joints in sizes from ¼" up with 4" or longer traverses.

WRITE FOR YOUR COPY OF CATALOG DESCRIBING COMPLETE LINE OF ADSCO PRODUCTS

AMERICAN DISTRICT STEAM COMPANY

NORTH TONAWANDA, NEW YORK

Makers of "UP-TO-DATE" Steam Line Equipment For Over 65 Years

For copies of manufacturers' literature or additional information on products described, use mailing card, at page 273.

which provides a more accurate and rapid method of interchanging and setting the chasers. This die head is of the internal tripped type, in which a 6-blade, insert-blade type, reamer located within the bore of the head, reams anid chamfers the pipe during the threading operation and, opens the head at any predetermined thread length. The semi-receding action on the head eliminates the possibility of any chaser-leave-off marks on the thread as the head opens up. The reamer is adjustable by an adjusting and clamping rod which extends through the machine spindle. Any desired thread length can be obtained by merely releasing the locking rod and turning the adjusting rod right hand or left hand to increase or decrease the thread length. Any thread length within standards is obtainable.

All parts of the head are made from either high-carbon or special-alloy steel, depending upon their function and are heat treated or case carborized and precision ground to assure maximum accuracy and long wearing quality. The head has remarkably few operating parts. All parts of this die head are thoroughly protected against wear. Zerk type fittings provide a means of forcing heavy grease into the chaser slides and other operating parts for lubricating purposes and also to act as a seal to prevent entry of fine cuttings and dirt to assure maximum life.

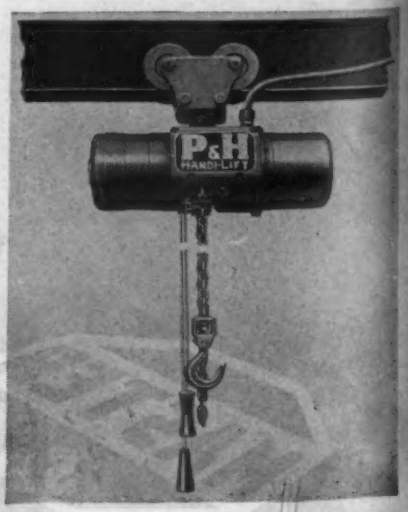
While the die head is designed primarily to operate as an internally tripped unit, this head can be opened and closed externally by means of an operating yoke.

9—Electric Hoist

Harnischfeger Corporation, Milwaukee, has developed an electric hoist known as P&H "Handilift" adaptable for bolt, hook, or trolley mounting, rated at 500 pounds capacity.

Fully-enclosed construction permits use inside or out. In trolley service, the hoist can be suspended either parallel or crosswise to the beam. Easy operation through a convenient pull cord leaves one hand free to guide the load.

Dual braking is provided by a spring-set brake which releases automatically



P&H "Handilift"

Hudson-built LIGHT HYDROCARBON PROCESSING PLANTS

Engineered Imagineered

HUDSON ENGINEERING CORPORATION

FAIRVIEW STATION — *Engineers and Constructors* — HOUSTON, TEXAS

FIGURE ON LOWER DRYING COSTS WITH DRIOCEL

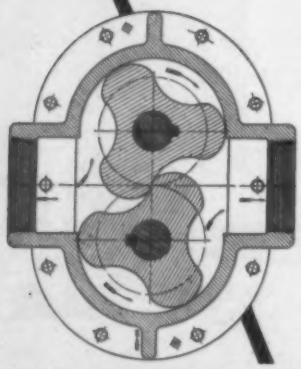
THE high adsorptive capacity of this specially activated bauxite desiccant assures bone-dry gases or liquids even after repeated regeneration. This continuing efficiency keeps drying costs low. Driocel is being used successfully in the petroleum and chemical industries to dry:

1 Feeds to alkylation and other catalytic processes.
2 Natural gas and pipeline gasoline.
3 Hydrocarbon gases, hydrogen and hydrogen sulfide, etc.
4 Liquid organic chemicals.

New applications for Driocel are being discovered every day, both in the field and by our own research men. It may help you improve your own processes and cut your costs. We'll be glad to talk it over. Just write Attapulgus Clay Company (Sales Agent), 260 South Broad St., Philadelphia 1, Penna.

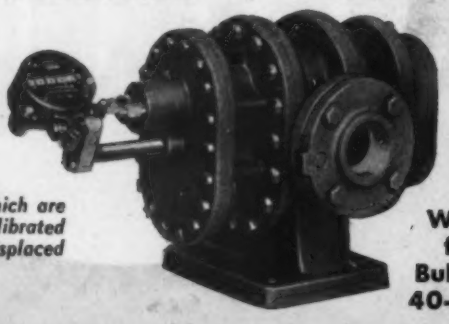
POROCEL CORPORATION • BAUXITE ADSORBENTS AND CATALYSTS

Permanently ACCURATE



The "R-C" Rotary Positive Oil Meter is of all-metal construction. No Adjustments. Accuracy is machined in and cannot be tampered with. No valves, orifices, springs, buckets, diaphragms or other parts to wear and destroy the accuracy of measurement. Compact single stuffing box design. Bearings and timing gears are lubricated by the oil being metered. Standard sizes from 40 to 740 GPM at pressures up to 100 lbs. Units built to order for special conditions.

ROOTS - CONNERSVILLE BLOWER CORP.
One of the Dresser Industries
509 Crescent Avenue Connersville, Indiana



The flow of oil rotates the impellers which are connected to a counter accurately calibrated in accordance with the exact volume displaced by each rotation of the empellers.

Write for Bulletin 40-B-15

Roots CONNERSVILLE SINCE 1854 Rotary Positive OIL METERS

For copies of manufacturers' literature or additional information on products described, use mailing card, at page 273.

when hoist is in operation and sets instantly with shutoff current. Lowering is controlled by dynamic means supplemented by the spring-set brake, which holds the load in the event of current failure.

Additional features include anti-friction bearings throughout, simplified planetary gear drive, flood lubrication, silver-to-silver switch contacts, high-starting torque, reversible motor with sealed bearings, wide-mouthed, forged-steel hook with ball bearings for free swiveling, and a yoke which serves as a clevis when the hook is removed.

Bulletin H-23 gives complete specifications.

10—Air and Water Savers

B. F. Goodrich Company, Akron, Ohio, is distributing a 22-page booklet on the Lonn rubber blow and spray guns and water savers. The booklet explains the Lonn valve which has only three working parts and gives constant fingertip control of air or water under pressure. Charts show the cost of water or air delivered through various orifices when uncontrolled.

11—Rotameter Rotor

Schutte & Koerting Company, 12 South 12th Street, Philadelphia 7, has announced a new patented rotor to facilitate rotameter readings of opaque liquids. Designated "Line-o-Light," this rotor, having the same basic design as a standard SK rotor, has a disc of light-transmitting material sandwiched in the rotor head, which substantially reduces the distance light must travel through the opaque liquid from its source behind the tube. Rate of flow is thus delineated sharply in the resultant band of light on the tube reference scale.

This rotor can be used for practically

Line-o-Light Rotor

TRIGGER-FINGER CONTROL

(For 10, 15 and 20-lb. Fire Extinguishers)

(1) SINGLE-FINGER OPERATION
Balanced pressure does the trick—
Easy trigger pull opens the valve

(2) LOW CENTER OF GRAVITY
That'll make these portables a lot easier to carry

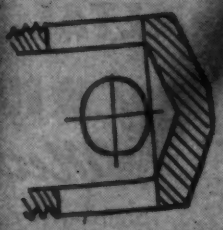
(3) INTERMITTENT OR CONTINUOUS CONTROL

(4) LOCK-OPEN CONTROL
Operated by trigger finger too

(5) NON-JAMMING LOCKING-PIN
Can't get bent over

(6) VISIBLE SEAL WIRE makes inspection easy

(7) IMPROVED RECOIL OUTLET



(8) RECHARGING WITHOUT REPLACEMENT PARTS
Simplifies putting extinguisher back in working condition after use.

(9) HYDROSTATIC TEST WHEN NECESSARY without devalving
A Novice can operate!

SAFE - FOOLPROOF - SIMPLE - STREAMLINED

10-, 15-, and 20-pound extinguishers with this new valve will be ready for delivery October 1st. Place your order now.

The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

Kidde

Walter Kidde & Company, Inc. • 140 Cedar Street, New York 6, N. Y.

"Foolish, Isn't It"
TO USE TWO INSULATING BLOCKS
Where ONE Will Do

KEL-BLOC
STRONG · FIREPROOF · CHEMICALLY STABLE
Highly Efficient at all Temperatures up to 1600° F
The M W KELLOGG CO.
REFRACTORIES DIV.

KEL-BLOC the ONE BLOC INSULATION is effective over the entire temperature range up to 1600° F.

Kel-Bloc is made from high temperature, moisture resistant long fibre black Rockwool, felt and bonded together by a special method which eliminates all voids and provides uniform stratification.

This light weight, insulating block has exceptionally low conductivity—due to the millions of dead air cells—and also has a low alkalinity factor remaining unaffected when exposed to moisture or high humidity.

A request for additional information will receive prompt attention.

M KELLOGG W

RECOMMENDED FOR INSULATING:
Pressure Vessels
Heat Exchangers
Steam Accumulators
Boilers
Furnaces
Oil Heaters
Dryers
Ovens
Breechings
Ducts

THE M. W. KELLOGG COMPANY
Sales Office: 225 Broadway, New York 7, N. Y. Plant: Jersey City, N. J.
REPRESENTATIVES IN CHICAGO · DETROIT · PITTSBURGH · LOS ANGELES

MULTI-METAL Pioneer of WIRE CLOTH Methods

SWD Bottom Wash Discharge Filter Leaf
DRUMTITE Metallic Bindings
HI-RATIO Screen
MULTIBRAID Metallic Filter Cloth
MULTILEAF For Filter Presses
MULTI-TWIST Cylinder Wires
RISTEX Screen
RING-KEY Filter Pads
SINGLEDISCS For Claytowers, etc.
SMOOTHBOLT Metallic Bolting Cloth
SMOOTHTEX Metallic Filter Cloth
WELDEDGE Metallic Binding

Multi-Metal Trade Names represent fabrication methods and new wire cloth weaves exclusive to MULTI-METAL. They mean methods famous in the industry —*pioneered* by *MULTI-METAL Research.*

Multi-Metal's policy to stress technical rather than commercial endeavor has made possible this superior screen and filter material which these names represent and which affords the utmost in service and economy.

Let us help you determine your wire cloth needs.

Wire Cloth
Filter Cloth
All Meshes
All Metals

Wire Cloth in Fabricated Units, or by the Roll and the Cut Piece. Send for our Interim Catalog.

Multi-Metal
WIRE CLOTH COMPANY, INC.
1350 Garrison Ave., New York 59, N. Y.

For copies of manufacturers' literature or additional information on products described, use mailing card, at page 273.

any application and in any type tapered-glass-tube rotameter. Two types of discs can be furnished: Lucite for general applications, and Pyrex glass for extremely hot or highly corrosive fluids.

12—Loupe

American Optical Company, Southbridge, Massachusetts, is making a new plastic Berger loupe which has a lightweight frame held comfortably by an elastic headband. It is adjustable for different facial contours and width between the eyes, and is well ventilated.

American Optical Company Loupe

It can be worn comfortably over glasses. Precision-ground lenses give a magnification of 2.5x. The instrument has innumerable applications in different fields where magnification is desired, with free use of the hands, and should be helpful to laboratory technicians and instrument men.

13—Fire Fighting

General Detroit Corporation, 2270 East Jefferson Avenue, Detroit 7, has suggested that safety engineers and executives concerned with fire protection secure from it an instructive folder to hold information pertaining to fire extinguishers. Material printed on the inside of this folder includes sketches of principal types of extinguishers, fires for which each is intended, and data on operation.

14—Synthetic Rubber

The B. F. Goodrich Company, Akron, Ohio, has available a new edition of its catalog section on the properties of Ameripol D, an oil- and heat-resistant synthetic rubber for specialized applications. Properties of Ameripol D are outlined in detail. Tables list the properties of typical commercially available Ameripol D compounds, and a guide to deter-

SOLVAY

49-50% tank car LIQUID

CAUSTIC POTASH

Solvay Liquid Caustic Potash meets the needs of refiners for a high quality alkali with *an absolute minimum of impurities.*

With a KOH content of approximately 50%, Solvay Liquid Caustic Potash is manufactured in Solvay's new potash plant—designed and built on the basis of Solvay's sixty-three years of experience in the manufacture and handling of alkalies.

In producing your high octane gasoline, depend on Solvay's exacting quality. Prompt shipment in tank cars from our Syracuse plant.

Solvay can meet your requirements . . . Write today!

SOLVAY SALES CORPORATION

Alkalies and Chemical Products Manufactured by The Solvay Process Company

40 Rector Street **New York 6, N. Y.**

BRANCH SALES OFFICES:

Boston 9, Mass.	45 Milk Street
Charlotte 2, N. C.	212 South Tryon St.
Chicago 2, Ill.	1 North LaSalle St.
Cincinnati 2, Ohio	3008 Carew Tower Building
Cleveland 15, Ohio	926 Midland Building
Detroit 32, Mich.	7501 West Jefferson Ave.
New Orleans 12, La.	1101 Hibernia Building
New York 6, N. Y.	40 Rector Street
Philadelphia 7, Pa.	12 South 12th St.
Pittsburgh 19, Pa.	1107 Gulf Building
St. Louis 8, Mo.	3615 Olive Street
Syracuse 1, N. Y.	Milton Ave.

"GUNITE"
CONCRETE LININGS

FOR:

BUBBLE TOWERS • STILLS • HOT OIL SEPARATORS • STORAGE TANKS • REFINERY VESSELS OF ALL TYPES • ENCASING AND FIREPROOFING STRUCTURAL STEEL AND PIPE • LINING WATER STORAGE RESERVOIRS, DITCHES AND CANALS • REPAIRING DISINTEGRATED CONCRETE AND MASONRY.

WRITE — PHONE — WIRE

GUNITE CONCRETE and CONSTRUCTION CO.

CEMENT GUN SPECIALISTS
ENGINEERS CONTRACTORS

1301 Woodswether Road
KANSAS CITY 6, MISSOURI

District Branch Office:
228 NORTH LA SALLE STREET, CHICAGO, ILL.

Branch Offices:
ST. LOUIS DENVER NEW ORLEANS HOUSTON

IMMEDIATE DELIVERY
6" BLACK LIGHT WT.

STEEL PIPE

Plain end for welding and grooved for Victaulic coupling.

★ 750,000 ft. 6" I.D.—6¼" O.D.—⅛" Wall. Test 900 lb.—Pressure 650 lb. Weight—approximately 8 lbs. per ft. 35c per ft., carload lots. F.O.B. New Orleans, Louisiana.

DEALERS INQUIRIES SOLICITED

For further information, write or call

GORDON IRON & SUPPLY CO.

Phone Wayside 2305 · 7152 Navigation Blvd.
HOUSTON, TEXAS

For copies of manufacturers' literature or additional information on products described, use mailing card, at page 273.

mine where the use of Ameripol D is practical. The section is illustrated with Ameripol D products of various types.

15—Dynamometer

W. C. Dillon & Company, 5410 West Harrison Street, Chicago 44, is distributing a booklet which is described as the first complete presentation in manual form of the story of the traction-type dynamometer and its uses in testing and weighing procedures.

16—Analysis of Test Data

Calco Chemical Division, American Cyanamid Company, Bound Brook, New Jersey, announces availability of its Technical Bulletin No. 773, "Statistical Analysis of Test Data," by E. I. Stearns of its research department. It is intended to arouse interest in statistical methods for quality control in production and the analysis of experimental data. It is instructive in pointing out fields of application but does not include detailed mathematical methods.

17—Cooling-Water Treatment

D. W. Haering & Company, 205 West Wacker Drive, Chicago 6, has issued a pamphlet which describes correction of an accelerated corrosion problem on the water side of process equipment used in the manufacture of synthetic dyestuffs. Plant operations contributed to a wide fluctuation in the chemical constituents of the recirculating cooling water, with some increasing from 30 to over 4000 parts per million in a matter of minutes.

18—Hydraulic Nozzles

Worthington Pump and Machinery Corporation, Harrison, New Jersey, is distributing Bulletin WP-1099-B43, "Industrial Application of High-Pressure Hydraulic Nozzles." Included in the text and illustrated with a diagram is data on hydraulic decoking of refinery vessels.

19—Chemical Scale Removal

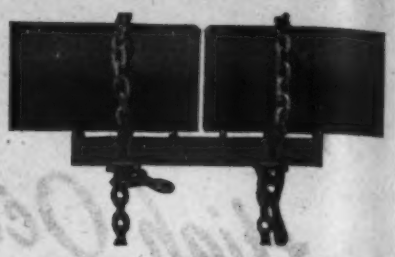
Dowell Incorporated, 524 Kennedy Building, Tulsa 3, Oklahoma, has issued an atractive 20-page illustrated bulletin on its chemical scale-removal service. It includes data of interest to power plant operators and chemists interested in removal of scale from boilers and heat exchangers.

20—Valves

The Wm. Powell Company, Cincinnati 22, Ohio, has issued "The Powell 'Quiz Kit'." Designed as an aid to valve selection, it contains much information on valves in general and those of the company's manufacture in particular.

21—Open Channel Meters

Bailey Meter Company, Cleveland 10, Ohio, has published Bulletin No. 62 featuring Bailey Open Channel Meters for sewage industrial wastes, sludge, and irrigation water. The meters described are of both the direct mechanical and the electronic telemeter type. Registers having various combinations of indicat-



WELD PIPE
Faster... Easier... Truer
WITH
JEWEL PIPE CLAMPS

They align pipe perfectly and hold it secure for tacking. On in a minute—off in ten seconds. Two sizes, ½ to 8 in. — 8 to 16 in. Rigid construction resists strain, heat, and abuse.

Other Jewel Clamps for Ells, long and short turn — for Flanges — for Headers. Also Pipe Marker, eliminates patterns for holes and saddles.

So simple — so easy to use — Jewel Tools are proving big time-savers in refinery piping fabrication and erection.

Write Today for Details and Prices.

JEWEL Manufacturing Company
1841 University Ave.
ST. PAUL 4, MINNESOTA

ESPECIALLY RECOMMENDED FOR USE IN THE

COPPER SWEETENING PROCESS

Nichols
TRIANGLE BRAND
COPPER SULPHATE

is preferred by leading refineries because of its high copper content, dependable uniformity and exceptional purity and freedom from foreign and inert matter.

99%+ PURE

Quotations on request, on any quantity required. Shipments can be made from our nearest plant.

PHELPS DODGE REFINING CORP.
40 WALL STREET, NEW YORK
230 N. MICH. AVE., CHICAGO

DESIGNING A HEAT-TIGHT WALL

It takes more than materials to design a heat-tight wall although each must be selected on the basis of their outstanding functions—refractories for protection against the furnace gases, insulation to stop the flow of heat, cast-iron members for sectional support, and a plastic material, applied with a trowel, to provide a permanent, weatherproof casing.

It takes more than merely tying these four elements together although they must be so integrated that they will function as a single unit, yet allow enough flexibility to provide for wide ranges of temperature.

What it takes is the know-how that comes from first-hand knowledge—knowledge acquired over thirty years of engineering heat enclosures. And it's Detrick that has had this long background of experience.

A new 80-page catalog presents the Detrick principles of construction which have been learned the hard way, in a graphic form which will bring any engineer up to date on the important subject of heat enclosures. If you have a problem along these lines up at present or contemplate one in the future, send for your copy today.

*The flexibility of Detrick design is demonstrated in the fact that this same type of construction is used on the refractory linings in 6 superheaters and 12 reactors at the Port Neches butadiene plant.

DETRICK FURNACE ENCLOSURES

M. H. DETRICK COMPANY
111 WEST WASHINGTON ST.
CHICAGO 2, ILLINOIS

QUICK TURBINE REPAIRS

If you need dependable Turbine repairs **in a hurry,** call us. We are completely equipped to repair and dynamically balance turbine rotors and any High Speed rotating elements in our modern shops.

25 Years Successful Experience

GULF ENGINEERING CO., INC.

"Service Not Promises"

307 M & M BUILDING HOUSTON, TEXAS

916 S. PETERS STREET NEW ORLEANS, LA.

McNAMAR

Steel Plate Fabricators and Contractors

•

Products Storage

•

Pressure Vessels

•

For more information See Page 371 in Refinery Catalog

McNAMAR BOILER & TANK CO.

Tulsa, Okla.

We design and construct all types of modern refining units.

★ Serving the Industry Since 1915

BORN ENGINEERING CO.

Tulsa, Oklahoma

For copies of manufacturers' literature or additional information on products described, use mailing card, at page 273.

ing, recording and integrating features are illustrated. All types of registers are said to be suitable for use with flumes, weirs, and atmospheric discharge nozzles.

22—Steam-Jacketed Rotary Pumps

Worthington Pump and Machinery Corporation, Harrison, New Jersey, has available Bulletin W-487-B11, descriptive of Worthington steam-jacketed rotary pumps for melted materials or highly viscous liquids requiring pre-heating.

23—Oil Pressure Unit

Durametallic Corporation, 2104 Factory Street, Kalmazoo 24F, Michigan, has issued a new bulletin on its Dura Pressure Unit. Certain improvements are incorporated in new designs of this oil pressure system, described and illustrated in this bulletin.

24—Chemicals

Hooker Electrochemical Company, Niagara Falls, New York, has issued a general products list, Bulletin 100, a folder containing brief information on nearly 100 chemicals. Data includes description, chief use and shipping-container information.

25—Steam Measurement

Fischer & Porter Company, Hatboro, Pennsylvania, has available a monograph for determining correct rotameter size for steam measurement.

26—Pulsation Dampener

The Fluor Corporation, 2500 S. Atlantic Boulevard, Los Angeles, has available a folder on its pulsation dampener for compressor installations. In addition to performance data on specific installations it contains some engineering data of interest.

27—Cold Water Deaeration

Cochrane Corporation, 17th Street and Allegheny Avenue, Philadelphia 32, is distributing its Reprint 43, "Cold Water Deaeration."

28—Equipment

General American Transportation Corporation, 530 Graybar building, New York 17, has issued Bulletin No. 300, "General American Equipment for the Oil Industry." Data are given on design, fabrication and erection of pressure vessels, absorbers, towers, heat exchangers, stills, kilns, treaters, filters and tanks.

CHEMIST OR CHEMICAL ENGINEER, experienced in petroleum refinery operations and pilot plant procedures; capable of correlating yield data, preparing reports, and guiding the progress of pilot plant operations; for a major engineering company in New York City. Address: Box 59-R, c/o Petroleum Refiner, Houston, Texas.

• **SALES ENGINEER AVAILABLE:** Graduate Engineer (E.E.) 15 years experience in instrumentation and control in Mid-Continent and Eastern industrial markets. Familiar with equipment, application and maintenance in refining, chemical and allied industries, also organization and management of industrial sales operations. Salary required $7,500. Preferred location Gulf Coast. Top references. Address: Box 33, c/o Petroleum Refiner, Houston, Texas.

AVAILABLE, graduate electrical-mechanical engineer desires to represent responsible companies as manufacturer's agent for the Houston Area. Houston Branch Office manager. Eighteen years successful sales engineering experience. Three years operating experience. Address: Box 786, c/o Petroleum Refiner, Houston, Texas.

ENGINEER familiar with Butane and Propane installation; capable of making plant surveys and flowcharts; supervise estimating, engineering and field erection. Salary commensurate with ability. Plant located in middle west. This is a real ground floor opportunity for the right man. Write giving complete personal data and experience. Address: Box R-109, c/o Petroleum Refiner, Houston, Texas.

Scientific Rust Control

PROTECT YOUR METAL SURFACES FROM CORROSION WITH

RUST-OLEUM

"The Miracle Paint"

IN COLORS AND ALUMINUM

RUST-OLEUM PAINT CORP.

TEXAS BRANCH

1935 COMMERCE STREET

RIVERSIDE 4847 — DALLAS 1, TEXAS

Distributors in Principal Cities

For

CORROSION RESISTING EQUIPMENT

See Page 991 1945 REFINERY CATALOG

The Edward Soph Co.

508-9 Daniel Bldg. Phone 3-6659

TULSA, OKLAHOMA